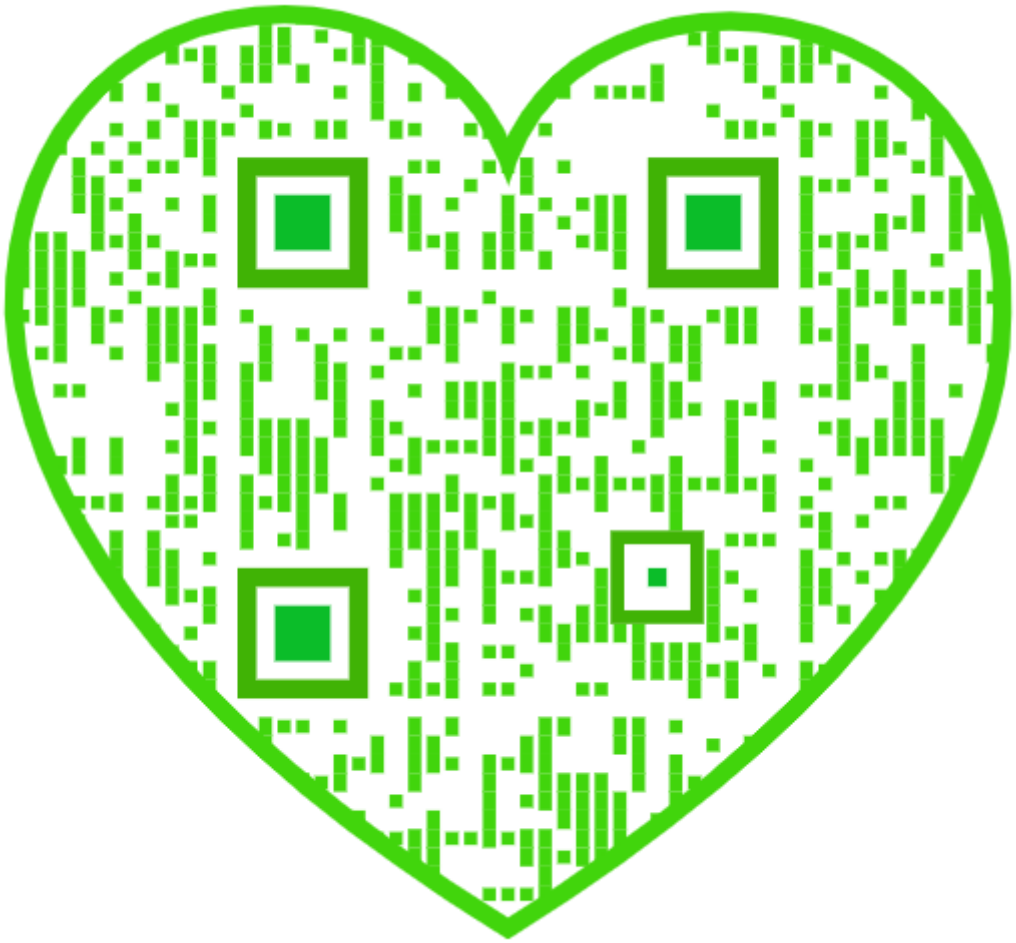

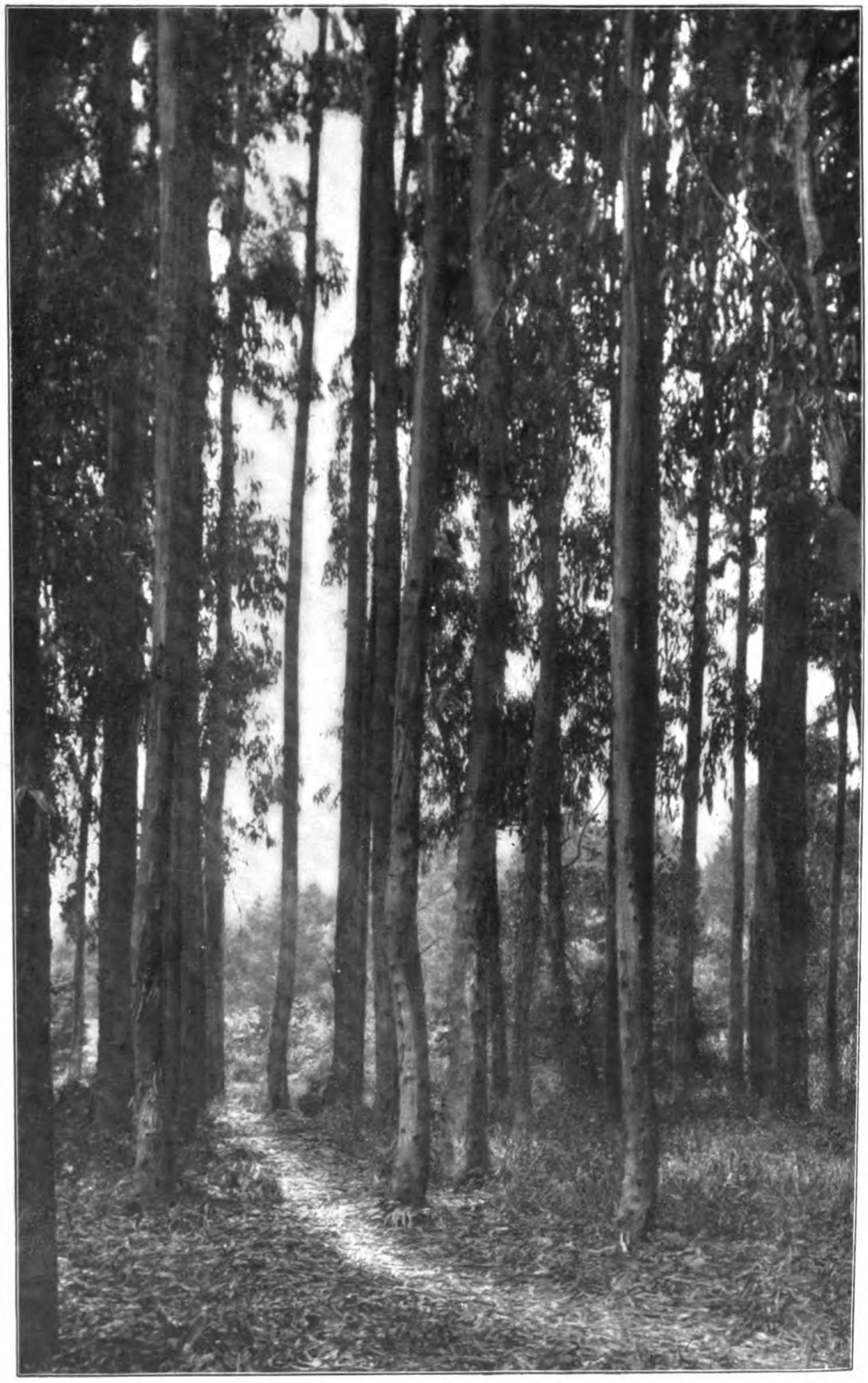

INTERIOR OF EUCALYPT GROVE.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF FORESTRY—BULLETIN No. 35.

GIFFORD PINCHOT, Forester.

EUCALYPTS CULTIVATED IN THE UNITED STATES.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY,
Washington, D. C., June 4, 1902.

SIR: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 35 of the Bureau of Forestry, a report entitled "Eucalypts Cultivated in the United States," by Prof. A. J. McClatchie, agriculturist and horticulturist of the Arizona Experiment Station, Phoenix, Ariz. Professor McClatchie has had excellent opportunities for studying the Australian Eucalypts, which are now extensively grown in the Southwest for ornament, for wind-breaks, and for their useful timber. The phenomenally rapid growth of the Eucalypts, and the special adaptation of many species to dry climates, render these trees of peculiar economic importance to the Southwest. The descriptions and illustrations of species, with the information upon their requirements of soil and climate, and upon the character and uses of their wood, together form a practical guide for the tree planter.

Very respectfully,

GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

The Eucalypts are now grown in America, especially in the Southwestern United States, more extensively than any other exotic forest tree. During the past forty years they have been planted here and in other parts of the world for ornament, for sanitary improvement, for shade, for wind-breaks, for fuel, for oil, and for timber; and incidentally they have been useful in many other ways. In fact, they have probably served more æsthetic and utilitarian purposes than any other forest trees that have been planted on this continent.

These trees have been studied and extolled alike by botanists, gardeners, and foresters. They are worthy of all the attention that has been given them and deserve to be still better known. The late Baron Ferdinand von Mueller, Government botanist of Victoria, Australia, the most renowned student of the great Australian genus Eucalyptus, prophesied in his scholarly Eucalyptographia that "The Eucalypts are destined to play a prominent part for all times to come in the silvan culture of vast tracts of the globe; and for hard-wood supplies, for sanitary measures, and for beneficent climatic changes all countries within the warmer zones will with appreciative extensiveness have to rely on our Eucalypts during an as yet uncountable period." All who have lived where Eucalypts grow can realize fully the force of the prophecy and the great value of the genus to mankind, both present and prospective.

In the following pages the Eucalypts are viewed mainly from the standpoint of their usefulness, only incidentally being treated as ornamentals. No attempt is made to present an exhaustive botanical treatise of the Eucalypts. The botanical features introduced are intended to be subservient to the interests and purposes of the forester.

Only the large arboreal species are discussed—that is, species attaining a height of over 40 to 50 feet and a diameter of over 1 foot. Many of the species consisting of smaller trees are very interesting to the botanist and gardener, but they are of comparatively little interest to the forester.

This publication is not a general treatise on the genus Eucalyptus,

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but has to do more especially with the genus as it behaves in North America. Only those species that have fruited and by this means have been identified are treated. This treatise is based mainly upon ten years' observation and study of the genus in California and Arizona and three years of experimental work in the latter region. Besides the data obtained as a result of this personal work, very much of value concerning the genus has been learned through correspondence with students and growers of Eucalypts in the various regions where they grow naturally or have been introduced. In this connection I wish to acknowledge especial indebtedness to the following persons for valuable assistance rendered: Hon. Abbot Kinney, Los Angeles; Hon. Ellwood Cooper, Santa Barbara; Mr. J. H. Maiden, F. L. S., government botanist, Sydney, Australia; Mr. F. Manson Bailey, F. L. S., colonial botanist, Brisbane, Australia; Prof. L. Trabut, Alger-Mustapha, Algiers; E. R. Holmes, Paris; Nathan W. Blanchard, Santa Paula, Cal.; and Col. G. H. Norton and A. K. Sanders, Eustis, Fla.

The purpose of this bulletin is to give information concerning the characteristics of the Eucalypts, their climatic requirements, and their uses; to give directions and suggestions as to their propagation and culture; and to furnish a means of identifying seedlings and mature trees, so that as the Eucalypts growing throughout the Southwest become identified, such trees may become sources of information concerning the species they represent, and sources of seed for propagation. This Australian group of trees now serves very many useful purposes in the Southwest, and gives promise of great future usefulness in the semiarid portions of our continent. It is believed that when the merits of these trees are fully understood, and information concerning their climatic requirements and their propagation is readily available, they will be planted more extensively and with increasing intelligence and discrimination. The covering of the now untillable, treeless portions of the semitropic section of America with such trees as Eucalypts, which will yield fuel, timber, and other useful products, and also furnish protection from the sun, from winds, and from floods, or otherwise ameliorate existing climatic conditions, is certainly an achievement greatly to be desired.

The illustrations are from photographs made by the writer during the past six years. Photographs of most of the seedlings in pots were made at a nursery in South Pasadena, Cal., the proprietors of which were extensive American growers of Eucalypts. The remainder were taken at the experiment station farm near Phoenix, Ariz. Seedlings 4 to 8 months old, as nearly typical of the respective species as possible, were selected for subjects. It is believed that these illustrations will prove useful to growers and purchasers in identifying seedlings of these

trees. The photographs of the branches bearing leaves, buds, flowers, and seed cases were taken in each instance from a specimen fastened to the trunk of the tree upon which it had grown, by this means showing fairly well the nature of the bark of the tree. It is thus attempted in each of these latter photographs to illustrate the principal features upon which the species are based, and it is hoped that they will be found helpful in identifying trees the names of which are unknown or doubtful.

CONTENTS.

PART I.

	Page.
The native home of the Eucalypts	13
The Eucalypts as exotics	14
Introduction over the globe	14
In southern Europe	15
In Africa	17
In southern Asia	17
In South America	18
In North America	18
Writers upon Eucalypts	20
Foreign	20
American	22

PART II.

Characteristics of the genus Eucalyptus	25
General characteristics	25
The trunk	26
The foliage	27
The bloom	27
The seeds	28
Relation of the Eucalypts to climate	29
General climatic requirements	29
Climatic areas in North America	29
Uses of Eucalypts	31
As a forest cover	31
As wind-breaks	33
As shade trees	34
As a source of timber	35
As a source of fuel	36
As a source of oil	38
As a source of honey	41
As improvers of climate	42
Propagation and care of Eucalypts	44
Difficulties in growing seedlings	44
Planting the seed	45
Transferring to fresh soil	45
Setting in the field	46
Subsequent care	47

PART III.

Page.
Principal species of Eucalypts grown in America, discussed as to characteristics, climatic adaptations, and uses 49
Eucalyptus amygdalina 51
Eucalyptus botryoides 53
Eucalyptus calophylla 53
Eucalyptus citriodora 54
Eucalyptus coriacea 55
Eucalyptus cornuta 56
Eucalyptus corymbosa 56
Eucalyptus corynocalyx 57
Eucalyptus crebra 59
Eucalyptus diversicolor 59
Eucalyptus eugenioides 60
Eucalyptus globulus 61
Eucalyptus gomphocephala 63
Eucalyptus goniocalyx 63
Eucalyptus gunnii 64
Eucalyptus hæmastoma 64
Eucalyptus hemiphloia 65
Eucalyptus leucoxylon 66
Eucalyptus longifolia 66
Eucalyptus macrorhyncha 67
Eucalyptus marginata 68
Eucalyptus melliodora 68
Eucalyptus microtheca 69
Eucalyptus obliqua 70
Eucalyptus occidentalis 70
Eucalyptus paniculata 71
Eucalyptus pilularis 71
Eucalyptus piperita 72
Eucalyptus polyanthema 73
Eucalyptus populifolia 73
Eucalyptus punctata 74
Eucalyptus resinifera 74
Eucalyptus robusta 75
Eucalyptus rostrata 76
Eucalyptus rudis 78
Eucalyptus saligna 79
Eucalyptus siderophloia 79
Eucalyptus sideroxylon 80
Eucalyptus stuartiana 81
Eucalyptus tereticornis 81
Eucalyptus viminalis 82
Grouping of species according to characteristics, climatic adaptation, and uses .. 84

PART IV.

Identification of Eucalypts 89
Systematic position of the Eucalypti 90
Botanical description of genus 90
Determination of species 91
Artificial keys to species 92
Botanical description of species 94
Bibliography of the genus Eucalyptus 99
Index 103

ILLUSTRATIONS.

Page.

Interior of Eucalyp grove ..... Frontispiece.

USES OF EUCALYPTS.

PLATE I. A. Eucalypts as forest cover for parks, East Lake Park, Los Angeles, Cal 16

B. Eucalypts as wind-breaks. Eucalyptus globulus protecting an orange orchard near Los Angeles, Cal 16

II. Eucalypts as avenue shade trees near Santa Monica, Cal.:

A. Eucalyptus cornuta 16

B. Eucalyptus corynocalyx 16

III. Public road near Alhambra, Cal 16

IV. The Blue Gum (Eucalyptus globulus) as a timber tree:

A. View in a grove twenty years old near Los Angeles, Cal 16

B. Cabin near Los Angeles. (Eucalyptus viminalis in foreground) 16

V. Eucalypts as a source of fuel:

A. Wood cut from a Blue Gum grove near Los Angeles, Cal 20

B. Wood cut from Red Gum (Eucalyptus rostrata) grove upon ranch of Ellwood Cooper, near Santa Barbara. (Young growth from stumps in background) 20

VI. A. Logs ready to be cut by steam sawing machine, visible in background 20

B. Four-foot wood, recently cut from grove of Blue Gum (Eucalyptus globulus) 20

VII. Blue Gums (Eucalyptus globulus) growing from stumps of trees cut for fuel:

A. One year's growth 20

B. Three years' growth 20

VIII. Eucalypts growing spontaneously under parent trees:

A. Eucalyptus rostrata at Cooper ranch, Santa Barbara, Cal ... 20

B. Eucalyptus rudis at Minnewawa ranch, Fresno, Cal 20

IX. Eucalypt seedlings in propagation boxes:

A. Ready to transfer to fresh soil 24

B. Ready to set in field 24

GROWING TREES.

X. Eucalyptus amygdalina, East Lake Park, Los Angeles, Cal 24

XI. Eucalyptus botryoides. Trees three years old 24

XII. Eucalyptus botryoides. Tree fifteen years old 24

XIII. Eucalyptus calophylla, East Lake Park, Los Angeles, Cal 28

XIV. Eucalyptus citriodora, tall form. Tree fifteen years old, Cooper ranch, near Santa Barbara, Cal 28

Page.

PLATE XV. Eucalyptus citriodora, spreading form. Trees twenty years old, Cooper ranch, near Santa Barbara, Cal. 28
XVI. Eucalyptus corymbosa, State Forestry Station, Santa Monica, Cal. 28
XVII. Eucalyptus corynocalyx, showing trunks suitable for fence posts. 32
XVIII. Eucalyptus crebra, Court-House Grounds, Fresno, Cal 32
XIX. Eucalyptus diversicolor, near South Pasadena, Cal 32
XX. Eucalyptus eugenioides, State Forestry Station, Santa Monica, Cal. 32
XXI. Eucalyptus globulus, Santa Barbara, Cal 36
XXII. Eucalyptus globulus on ranch of Ellwood Cooper, Santa Barbara, Cal 36
XXIII. Eucalyptus globulus. Timber cut from trees in the background being used to build fence 36
XXIV. Eucalyptus gomphocephala. Grove 24 years old on the Cooper ranch 36
XXV. Eucalypts on ranch of Ellwood Cooper, Santa Barbara, Cal.:
A. Eucalyptus goniocalyx. Trees 24 years old 40
B. Eucalyptus tereticornis. Trees 22 years old 40
XXVI. Eucalyptus hemiphloia. Tree 4 years old, Experiment Station Farm, Phoenix, Ariz 40
XXVII. Eucalyptus hemiphloia. Trees 24 years old, Cooper ranch, Santa Barbara, Cal 40
XXVIII. Eucalyptus leucoxylon. State Forestry Station, Santa Monica, Cal 44
XXIX. Eucalyptus leucoxylon. Tree 10 years old, Capitol grounds, Phoenix, Ariz 44
XXX. Eucalyptus longifolia, Pasadena, Cal 44
XXXI. Eucalyptus melliodora, State Forestry Station, Santa Monica, Cal. 44
XXXII. Eucalyptus microtheca, Montecito, Cal 48
XXXIII. Eucalyptus occidentalis, near Santa Monica, Cal 48
XXXIV. Eucalyptus paniculata, State Forestry Station, Santa Monica, Cal. 48
XXXV. Eucalyptus pilularis, near Santa Monica, Cal 48
XXXVI. Eucalyptus polyanthema, on grounds of George C. Roeding, Fresno, Cal 52
XXXVII. Eucalyptus robusta, near South Pasadena, Cal 52
XXXVIII. Eucalyptus rostrata. Trees 8 years old, East Lake Park, Los Angeles, Cal 52
XXXIX. Eucalyptus rostrata. Trees 24 years old, near Ocean Bluff, Santa Barbara, Cal 52
XL. Eucalyptus rostrata (Red gum), near Glendale, Ariz 56
XLI. Eucalyptus rostrata (Red gum), Phoenix, Ariz 56
XLII. Eucalyptus rudis, on grounds of Minnewawa ranch, Fresno, Cal. 56
XLIII. Eucalyptus rudis, on Minnewawa ranch, Fresno, Cal 56
XLIV. Eucalyptus siderophloia. Trees 8 years old, East Lake Park, Los Angeles, Cal 60
XLV. Eucalyptus sideroxylon, Montecito, Cal 60
XLVI. Eucalyptus viminalis. Tree 24 years old, Pasadena, Cal.; diameter of trunk over 5 feet 60
XLVII. Eucalyptus viminalis, South Pasadena, Cal. Trees 12 years old. 60
XLVIII. Eucalyptus viminalis, Montecito, Cal. Trees 20 years old 64
XLIX. Eucalyptus viminalis, Montecito, Cal. Trees 20 years old growing among native shrubs and trees 64

LEAF, FLOWER, SEED-CASE, BARK.

		Page.
PLATE L.	Eucalyptus amygdalina	64
LI.	Eucalyptus botryoides	64
LII.	Eucalyptus calophylla	64
LIII.	Eucalyptus citriodora	64
LIV.	Eucalyptus cornuta	64
LV.	Eucalyptus corymbosa	68
LVI.	Eucalyptus corynocalyx	68
LVII.	Eucalyptus crebra	68
LVIII.	Eucalyptus diversicolor	68
LIX.	Eucalyptus eugenioides	68
LX.	Eucalyptus globulus	68
LXI.	Eucalyptus gomphocephala	68
LXII.	Eucalyptus goniocalyx	68
LXIII.	Eucalyptus gunnii	72
LXIV.	Eucalyptus hemiphloia	72
LXV.	Eucalyptus leucoxylon	72
LXVI.	Eucalyptus macrorhyncha	72
LXVII.	Eucalyptus melliodora	72
LXVIII.	Eucalyptus microtheca	72
LXIX.	Eucalyptus obliqua	72
LXX.	Eucalyptus occidentalis	72
LXXI.	Eucalyptus polyanthema	76
LXXII.	Eucalyptus resinifera	76
LXXIII.	Eucalyptus robusta	76
LXXIV.	Eucalyptus rostrata	76
LXXV.	Eucalyptus rudis (tree 12 years old)	80
LXXVI.	Eucalyptus rudis (tree 6 years old)	80
LXXVII.	Eucalyptus siderophloia	80
LXXVIII.	Eucalyptus sideroxylon	80
LXXIX.	Eucalyptus tereticornis	80
LXXX.	Eucalyptus viminalis	80

SEEDLINGS.

LXXXI.	A. Eucalyptus calophylla	80
	B. Eucalyptus corymbosa	80
	C. Eucalyptus corynocalyx	80
	D. Eucalyptus citriodora	80
LXXXII.	A. Eucalyptus coriacea	80
	B. Eucalyptus eugenioides	80
	C. Eucalyptus occidentalis	80
	D. Eucalyptus cornuta	80
LXXXIII.	A. Eucalyptus siderophloia	84
	B. Eucalyptus diversicolor	84
	C. Eucalyptus globulus	84
	D. Eucalyptus gomphocephala	84
LXXXIV.	A. Eucalyptus rudis	84
	B. Eucalyptus goniocalyx	84
	C. Eucalyptus stuartiana	84
	D. Eucalyptus gunnii	84
LXXXV.	A. Eucalyptus paniculata	84
	B. Eucalyptus hæmastoma	84
	C. Eucalyptus hemiphloia	84
	D. Eucalyptus crebra	84

		Page.
PLATE LXXXVI.	A. Eucalyptus leucoxylon	84
	B. Eucalyptus sideroxylon	84
	C. Eucalyptus robusta	84
	D. Eucalyptus longifolia	84
LXXXVII.	A. Eucalyptus melliodora	90
	B. Eucalyptus polyanthema	90
	C. Eucalyptus obliqua	90
	D. Eucalyptus pilularis	90
LXXXVIII.	A. Eucalyptus resinifera	90
	B. Eucalyptus punctata	90
	C. Eucalyptus tereticornis	90
	D. Eucalyptus rostrata	90
LXXXIX.	Young Eucalypts at Experiment Station Farm, Phoenix, Ariz.:	
	A. Eucalyptus rudis (1 year old)	96
	B. Eucalyptus polyanthema (2 years old)	96
XC.	Eucalyptus fruits	96
XCI.	Eucalyptus fruits	96

EUCALYPTS CULTIVATED IN THE UNITED STATES.

PART I.

THE NATIVE HOME OF THE EUCALYPTS.

The native home of the Eucalypts is Australia and some of the adjacent islands, including Tasmania, New Guinea, Timor, and one of the Moluccas. All but a very small per cent of the species are found on the continent of Australia itself. A small number grow both on Tasmania and in Australia, one of these being the Blue Gum, *Eucalyptus globulus*, the species that has been cultivated most widely throughout other parts of the world.

The Eucalypts constitute a considerable part of the forests of Australia, and are said to give a characteristic appearance to the landscape of the regions in which they grow. They are known in their native home as Gum trees, Mahogany trees, Box trees, Stringy barks, and by quite a number of other names, the first being the most common appellation. Notwithstanding the general use of the term "Gum tree," the name is not an entirely appropriate one, as the exudations from the trees are in most cases not gums, but resins. The name "Eucalypts," proposed by Baron von Mueller, and used in this publication, is more suitable and euphonious. The only Australian common names that have been generally adopted in America are "Blue Gum tree" for *E. globulus*, and "Red Gum tree" for *E. rostrata* and several other species, indiscriminately. In Australia several species are known as Blue Gums and several as Red Gums. This confusion of names, due to the great number of the species, and to the application to the same species of different common names by the inhabitants of the various colonies of Australia, makes it impracticable to designate a Eucalyptus tree by a common name. For distinctness it is necessary to use the botanical names almost entirely. It will probably be some time, even in their native home, before these trees have well established popular names for each of the 150 or more species.

In Australia the different species occupy situations varying from deserts or dry mountainous regions to low, swampy, and moist mountainous ones. On account of the great diversity of species and their wide distribution in their native home, it has been possible to select

species suitable to a great variety of semitropic situations; and there are undoubtedly greater future possibilities along this line. Each year one or more additional promising species finds its way from Australia to our continent, the usefulness of the genus being thus continually extended to new regions. As Americans become better acquainted with the Eucalypts in their native home the possibilities for the usefulness of these trees upon our continent will be increased.

THE EUCALYPTS AS EXOTICS.

INTRODUCTION OVER THE GLOBE.

From Australia the Eucalypts have been carried to many parts of the earth having a similar climate. The dissemination began on an extensive scale about the middle of the past century, largely through the labors of Baron von Mueller in Australia and of M. Ramel in Australia and in Europe. To be sure, small plantings had been made in Europe and in Africa earlier in the century, but we are indebted to these men for an adequate appreciation of the real merits of the genus. Prof. J. E. Planchon, one of the students and disseminators of Eucalypts in France, says of these men in his paper upon the *Eucalyptus globulus*,[a] that their memory should be associated with the name Eucalyptus "wherever this tree thrives as a source of public wealth and salubrity;" and then adds:

> In the history of the future naturalization of the Eucalyptus, Mueller is the savant who justly calculated the future of the tree, traced it in its [prospective] itineracy, and predicted its destiny. Ramel is the enthusiastic amateur who has thrown body and mind into the mission of propagating it. Both have faith, but one is a prophet, the other an apostle; and, in the noble confraternity of services, public gratitude will not separate the names that are bound together by friendship.

Others took up the good work in various parts of the world, and, during the quarter of a century that followed, the genus became widely distributed. It is said that more trees of this genus have been planted away from its original habitat than of all other forest trees combined. As an indication of how extensively they were being planted a quarter of a century ago, the following statement from a seed catalogue published in Sidney in 1875 is of interest:

> To give our friends some idea of the demand: We have sold nearly half a ton of seed during the past year. One pound weight should produce many thousand plants.

The present generation is reaping the benefit of the extensive planting of that period.

The Eucalypts are now grown successfully in southern Europe, in northern and in southern Africa, in southern Asia, in parts of South America, and in the Southern part of North America. Thus, a por-

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[a] Revue des Deux Mondes, January, 1875. Translated and published by Department of Agriculture, May, 1875.

tion of each continent of the globe is receiving the benefit of the distribution of this useful genus from its native home. In many of the above regions the Eucalypts are a conspicuous feature of the country, the aspect of the landscape having in some cases been completely changed by the planting of these trees. There are undoubtedly many other parts of the earth yet to be benefited by the introduction and extensive planting of species adapted to the climatic conditions. The tests of various species made in Arizona by the writer, during the past three years, indicate that there are species of Eucalypts adapted to many regions where they have not been tried. These experiments indicate also that in localities where it has been supposed they could not be grown successfully as forest trees suitable varieties have not been tried. There is need of a careful study of these trees in their native habitats, in order to determine what species may be introduced into regions with climate and soil similar to those of the districts in which the respective species grow naturally.

IN SOUTHERN EUROPE.

According to Baron von Mueller Eucalypts were first planted in Europe in the botanic garden of Naples, in the early part of the last century. But their value as forest trees was not recognized anywhere in southern Europe until after the middle of the century, and in Italy not until 1870. During the past forty years their culture has increased rapidly. Claude M. Thomas, American consul at Marseilles in 1894, states, in Consular Reports No. 168, that "the cultivation of the Eucalyptus is receiving much attention from thoughtful men, wherever in Europe climate and soil are of a character adapted to its growth."

The French botanists and gardeners were pioneers in studying Eucalypts and in distributing them throughout southern Europe. Their interest seems to have continued unabated for nearly half a century, more publications on the culture and uses of the Eucalypts having appeared in the French language in that time than in any other, and probably more than in all other languages in which such treatises have been written. The Eucalypts were introduced into France during or before 1854, and during the succeeding quarter century were planted extensively. Planchon said in 1875:

> Now the entire region from Cannes to Monaco displays to the traveler * * * the aspiring branches of the Eucalyptus, with their scythe-shaped leaves trembling beneath the slightest breeze, and withstanding the repeated and violent winds from the east.

M. Henri Carreron, in an article in a recent number of the Journal de Genève, makes the following statements concerning the present prevalence of Eucalypts in southeastern France:

> A Provençal who has not seen the Côte d'Azur for the last forty years would not

recognize it, so changed is the aspect of its vegetation. No more there of those characteristic, stunted, grayish bushes. They have been replaced on at least one-fourth of the surface of the land by cooling and fragrant forests of huge Eucalypts, which tower high above the thousand-year-old Olive and Mastic trees. Australia is invading the ancient Provence; the antipodean forest is gradually taking the place of the indigenous species of the Old World.

Felix Sathut states in his Les Eucalyptus, published in 1888, that—

The Eucalyptus * * * is certainly of all the exotic trees thus transplanted the one which excites the most astonishment by the rapidity of its growth, its gigantic proportions, and the very great diversity of its appearance and foliage. It is already so abundant that it is encountered at every step in the public places, in all the gardens, and it is already being used as a forest sort.

In France, Eucalyptus culture is still confined almost exclusively to the Mediterranean coast region, no species having been generally introduced that will withstand the frosts that occur at most points to the north of this favored maritime district. From that country culture has extended into most of the region about the Mediterranean, including its islands. On the island of Corsica these trees have been grown with special appreciation of their value, several publications having been written concerning their culture there.

In Italy, Eucalypts were grown previous to 1870 simply as botanical or ornamental specimens. During that year they were first set in large numbers for the sanitary improvement of a locality. The most extensive planting made that year was by the Trappist monks at Tres Fontane in the Campagna Romana, where malaria was very prevalent. Charles Belmont Davis, American consul at Florence in 1894, writes, in Consular Reports No. 168, that—

A few monks used to go to this place from Rome every morning after the sun had cleared away the fog, plant as many of the *Eucalyptus globulus* as they could during the day, and return to the city in the evening. * * * Over 55,000 Eucalyptus trees are planted at this place to-day. * * * At present Italy has at least 100,000 Eucalyptus under successful cultivation, 30,000 of which are due to the railway companies and 70,000 to private enterprise.

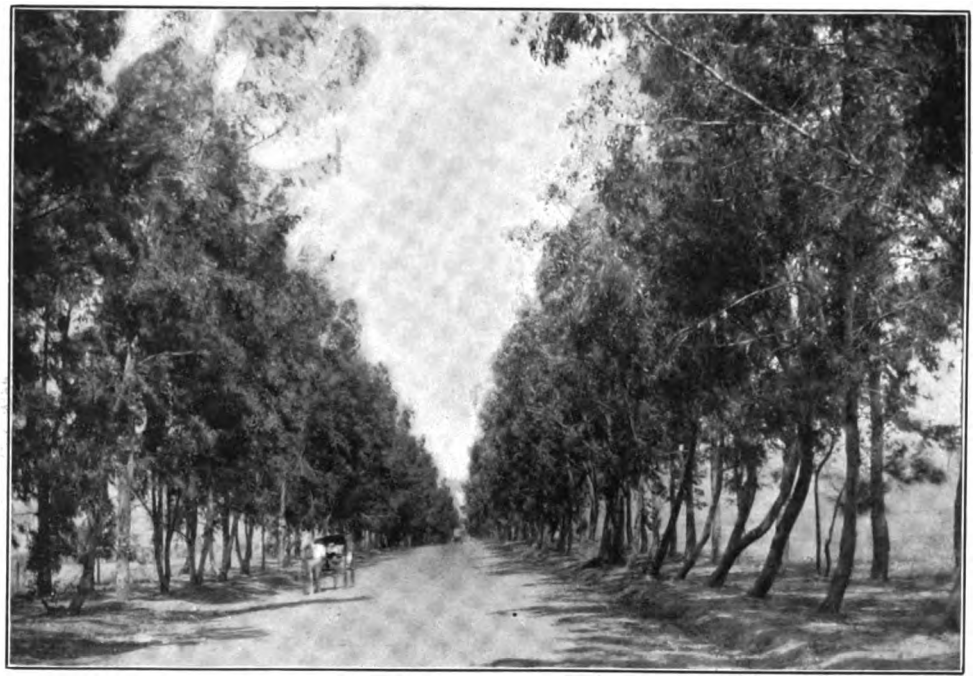
According to a report made by Herbert W. Bowen, American consul at Barcelona, in 1894, Eucalypts were introduced into Spain in 1865, where *Eucalyptus globulus* became known as the "fever tree," "because it is believed to purify boggy and aqueous regions that engender fevers." Mr. Bowen writes:

The French are the most active and intelligent (if we leave our own Californians out of the question) in propagating the tree. Hardly less sanguine than the French are * * * the Spaniards, who hope by cultivating the Eucalyptus to eliminate from the atmosphere the noxious exhalations of their soil, and to secure an ample supply of woodland and wood.

In Portugal and in Greece Eucalypts are grown successfully, but have not yet been planted on so extensive a scale as in other parts of southern Europe.

A. EUCALYPTS AS FOREST COVER FOR PARKS, EAST LAKE PARK, LOS ANGELES, CAL.

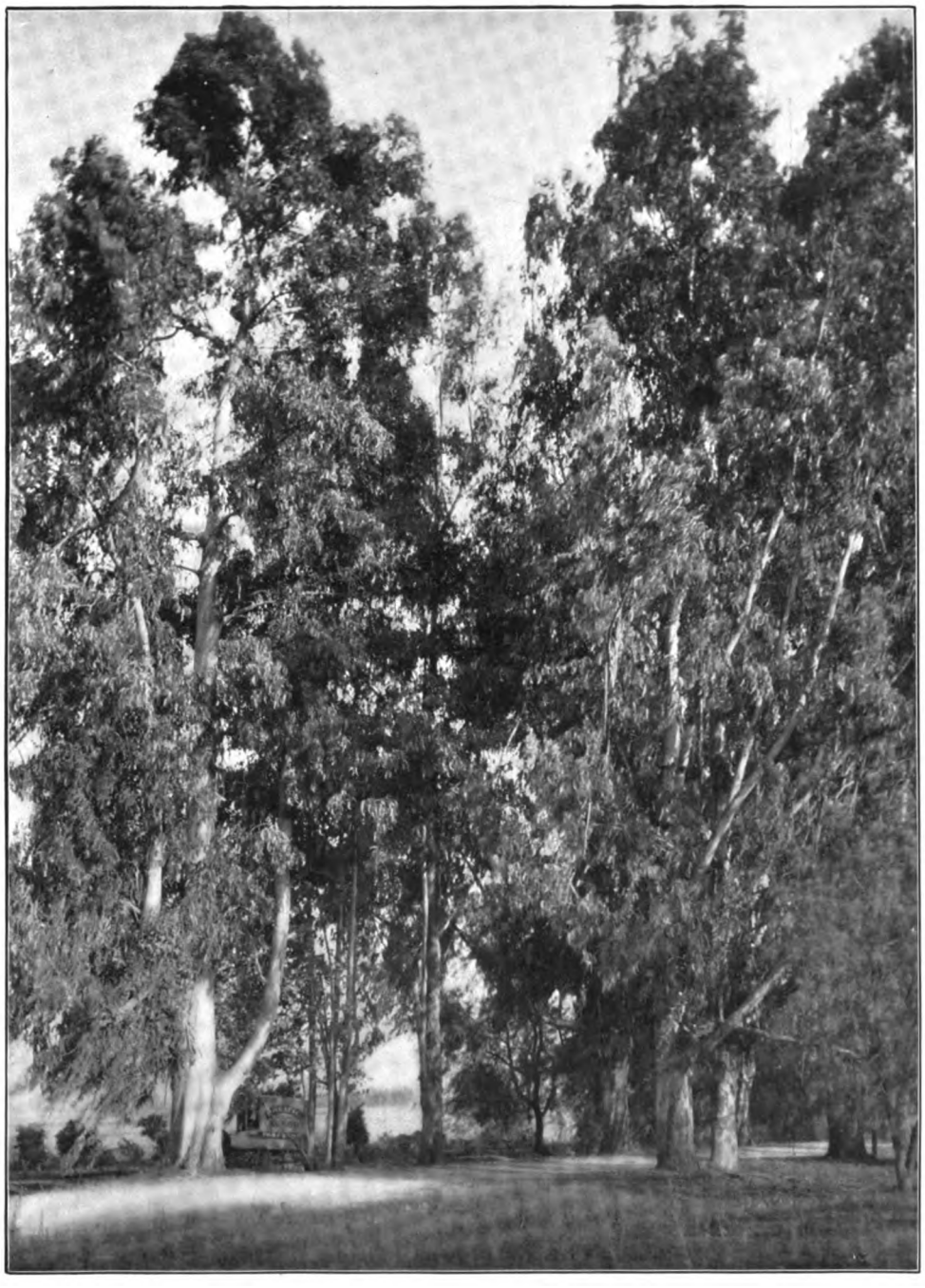
B. EUCALYPTS AS WIND-BREAKS. EUCALYPTUS GLOBULUS PROTECTING AN ORANGE ORCHARD NEAR LOS ANGELES, CAL.



A. EUCALYPTUS CORNUTA.

B. EUCALYPTUS CORYNOCALYX.

EUCALYPTS AS AVENUE SHADE TREES NEAR SANTA MONICA, CAL.



PUBLIC ROAD NEAR ALHAMBRA, CAL.

A. VIEW IN A GROVE 20 YEARS OLD NEAR LOS ANGELES, CAL.

B. CABIN NEAR LOS ANGELES. (EUCALYPTUS VIMINALIS IN FOREGROUND.)

THE BLUE GUM (EUCALYPTUS GLOBULUS) AS A TIMBER TREE.

IN AFRICA.

About the same time that the Eucalypts were introduced into France they were carried into the French colonies in northern Africa. The Blue Gum (*Eucalyptus globulus*) is reported to have been introduced into Algeria in 1854, a little over half a century after the discovery of the species in Tasmania by La Billardière. By the year 1875, according to Planchon, it had been planted in northern Africa "by hundreds of thousands, in groves, in avenues, in groups, in isolated stalks, in every section of three provinces; and the foreigner who does not know the exotic origin of the Eucalyptus would suppose it to be an indigenous tree." He adds: "No tree has in so short a space of time introduced into the forest vegetation of Algeria so picturesque an element, or is as useful and as promising for the future."

Prof. Louis Trabut, Government botanist of Algeria, wrote to the author as follows, under date of October 14, 1900:

> Relative to the Eucalyptus, this tree has been planted in Algeria since 1870. Only *E. globulus* was planted for several years. Lately they have planted *E. rostrata*. These are the only species that have been generally planted. Among amateurs 100 other species may be found. The Eucalyptus has rendered great service to the country in quickly growing wood for the timbers of sheds and other farm buildings.

Eucalyptus culture has continued to spread, now extending throughout other parts of the continent, more especially in the English and Dutch colonies of southern Africa. James Bryce, in his Impressions of South Africa, published in 1897, says, concerning the planting of Eucalypts in the latter region:

> The want of forests in South Africa is one of the greatest misfortunes of the country, for it makes timber costly. * * * Unfortunately, most of the South African trees grow slowly; so where planting has been attempted it is chiefly foreign sorts that are tried. Among these the first place belongs to the Australian gums, because they shoot up faster than any others. One finds them now everywhere, mostly in rows or groups around a house or a hamlet, but sometimes also in regular plantations. They have become a conspicuous feature in the landscape of the veldt plateau, especially in those places where there was no wood, or the little that existed has been destroyed. * * * If this goes on, those Australian immigrants will sensibly affect the aspect of the country, just as they have affected that of the Riviera in southeastern France, of the Campagna of Rome, of the rolling tops of the Nilghiri hills in South India.

IN SOUTHERN ASIA.

It is reported that the Eucalypts were introduced into southern India as early as 1843. Several thousand acres are now covered with these trees, principally upon the Nilghiri and Palui hills. In parts of India a great variety of Eucalypts thrive, while in other sections only a limited number of species can be grown. Some large plantations there are now 40 years old. In the consular report for Sep-

tember, 1894, V. L. Polk, then consul-general at Calcutta, remarks concerning the Blue Gum (*Eucalyptus globulus*): "It may be said generally that the growth of this species is an unqualified success."

IN SOUTH AMERICA.

The Eucalypts have been grown in parts of South America for over thirty years. Interest in them in the Argentine Republic was aroused by the careful work of Dr. Ernest Aberg, who conducted cultural experiments with the genus and in 1874 published a work upon the importance of these trees for a wood supply. They are grown to some extent in Peru, in Venezuela, and in other parts of the continent.

IN NORTH AMERICA.

The Eucalypts were introduced into North America only a few years after their introduction into France and Algeria, the merits of the genus being early recognized by Californians. It is reported that they were introduced into California in 1856 by Mr. Walker, of San Francisco, and in that year 14 species were planted. In 1860 Mr. Stephen Nolan, a pioneer nurseryman of Oakland, being greatly impressed with the rapid growth of these first trees, and also with their evident adaptability to the climate, commissioned a sea captain sailing for Australian ports to secure any Eucalyptus seed he could, at the same time furnishing money with which to make the purchase. A large supply of seed of several species, including *Eucalyptus viminalis*, was received from this source, and sown in 1861. Mr. Nolan continued to import seed in quantity for several years, distributing the seedlings widely through the State.

The country is especially indebted to Hon. Ellwood Cooper for calling attention to the merits of the Eucalypts. For many years he was very active in bringing the genus to the attention of the citizens of California. Under date of May 28, 1900, he writes:

> There were Blue Gum trees growing in the State during my first visit in 1868. I saw a few specimens in private gardens from 10 to 20 feet high; was attracted to their beauty; so that when I located in Santa Barbara, in 1870, I at once conceived the idea of forest planting.

In 1875 he delivered in Santa Barbara a lecture in which his enthusiasm for the genus found expression. This was probably the first address on the subject in America. His interest in these trees (and, incidentally, the rapidity of their growth, which is one of the causes of their rapid introduction) is shown by the following statement made by him upon that occasion:

> At my home I have growing about 50,000 trees. The oldest were transplanted three years ago. A tree three years and two months from the seed, transplanted two years and ten months ago, is 9½ inches in diameter and 42 feet 6 inches high.

During the intervening quarter century Mr. Cooper has continued the extensive planting of Eucalypts. He has set them in canyons and on steep hillsides, has utilized them for a forest cover, for wind-breaks, for shade on avenues, for sources of timber and wood, as well as for ornament, thus furnishing the country an object lesson of what the tree will do for an appreciative planter. He now has about 200 acres of his ranch north of Santa Barbara covered with forests of these trees. Here is the best place in America to see a large variety of Eucalypts grown as forest trees. Several varieties to be seen only as botanical or ornamental specimens elsewhere can be seen here growing by the acre. Mr. Cooper's groves have been and will continue to be valuable sources of information as to the behavior, when growing in forests, of several species not yet generally planted in America.

A great impetus has been given the planting of Eucalypts in the southwestern United States by the labors of Hon. Abbot Kinney, of Los Angeles. As chairman of the California Board of Forestry from 1886 to 1888 he rendered a great service to the State in causing the planting of thousands of Eucalypts within her borders. A large percentage of the trees of species other than *Eucalyptus globulus*, now growing in the Southwest, are from plants distributed during his administration. Mr. Kinney has ever since been an enthusiastic student and planter of trees of this genus, and has written more upon Eucalypts than any other American. In southern California especially, and in Arizona also, the planting of these trees has been extended very much by his work.

During recent years the planting of Eucalypts has been stimulated by the labors of Mr. A. Campbell-Johnston, of Garvanza, Cal., an ardent student and admirer of these trees, who by his writings and his example has done much to attract attention to the merits of the genus. The firm with which he is connected at South Pasadena, Cal., is rendering a service of incalculable value in furnishing for planting authentically named seedling Eucalypts. Mr. Campbell-Johnston is also conducting at his ranch the most extensive cultural test of species of Eucalyptus that has been made in America.

It is through the labors of such men as have been mentioned, and of many others, that the Eucalypts have become disseminated and recognized and very generally planted throughout California. The landscape of many parts of the State has been completely changed by the growth of these trees. Over much of the State they are the principal wind-break, shade, and fuel trees, and the number of useful purposes they serve is continually increasing. Without the Eucalypts California would be a very different State, and their value to the Commonwealth is beyond calculation.

From California the planting of Eucalypts extended into Arizona,

New Mexico, Texas, and Florida. In most cases the Blue Gum (*Eucalyptus globulus*), the species that had been most successfully grown in California, was the one first planted in these regions. The Blue Gum is not adapted to these regions and this has led to the belief that no Eucalypts would thrive there. In southern Arizona, for example, the Blue Gum does not endure the dry heat of summer, while in Florida the frosts of winter have been fatal to it. But in some of these places more resistant species have been introduced and are growing satisfactorily. A more careful and systematic study of the genus, accompanied by cultural tests, will undoubtedly result in the discovery of additional and probably better species for these and other regions.

Eucalypts have been introduced from California into Mexico also, and their merits are being gradually recognized there.

The introduction of heretofore untried species is continuing in the Southwest, and the number grown there is thus rapidly increasing. During the past three or four years especially a great many species have been added to the list of those grown in America. The forty species discussed at length in this publication comprise the species known to the writer that have been introduced long enough to produce seed, and thus establish their identity. Five years hence a large number of additional species will have fruited, and a publication covering the same ground that this one aims to cover would then include nearly twice the number discussed in these pages. The recently introduced species are growing mostly at the University of California, at forestry stations at Santa Monica and Chico, on the ranch of A. Campbell-Johnston (Garvanza), in Elysian Park (Los Angeles), and upon the experiment station farm near Phœnix. Their development is being closely watched by those interested in their planting, and by whom the great future possibilities in these recent arrivals from the native home of the genus is fully realized.

WRITERS UPON EUCALYPTS.

FOREIGN.

Much has been written concerning this very interesting group of trees. Most of the publications have been in English and in French—several score in each language. A few have appeared in Italian, a few in German, and a few in Spanish.

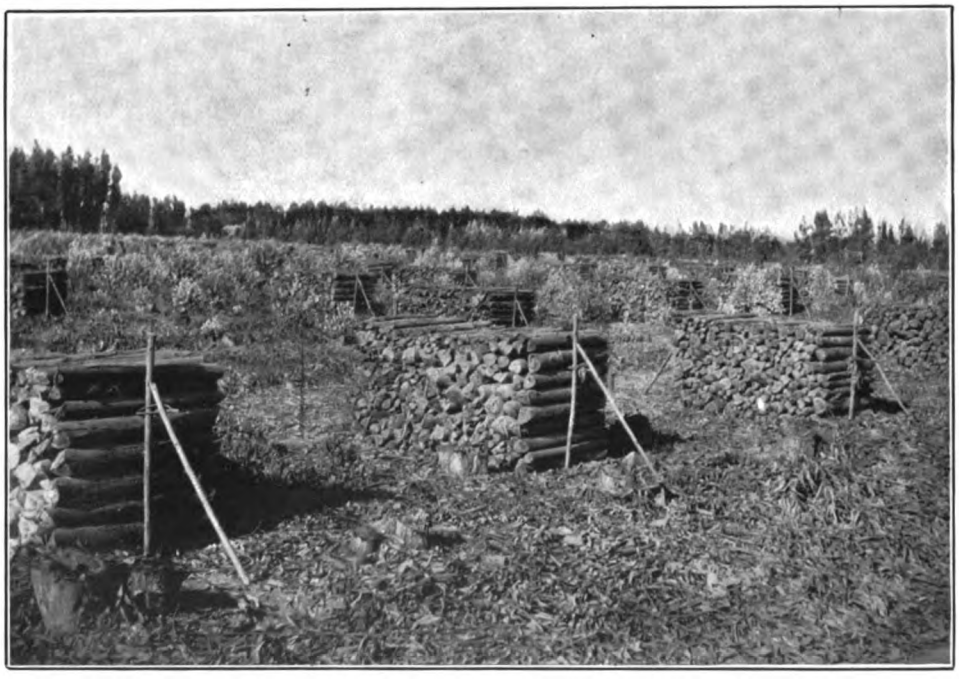
The most comprehensive work on the Eucalypts is Baron von Mueller's Eucalyptographia, a ten-part illustrated monograph, published by the government printer at Melbourne, Australia, and by Trubner & Co., London, 1879 to 1884. One hundred species are illustrated and described, with their climatic requirements and their uses quite fully given. Baron Von Mueller expressed in the final number a hope that during the years remaining to him supplemental parts might be

A. WOOD CUT FROM A BLUE GUM GROVE NEAR LOS ANGELES, CAL.

B. WOOD CUT FROM RED GUM (EUCALYPTUS ROSTRATA) GROVE UPON RANCH OF ELLWOOD COOPER NEAR SANTA BARBARA, CAL. (YOUNG GROWTH FROM STUMPS IN BACKGROUND.)

EUCALYPTS AS A SOURCE OF FUEL.

A. LOGS READY TO BE CUT BY STEAM SAWING MACHINE. VISIBLE IN BACKGROUND.



B. FOUR-FOOT WOOD RECENTLY CUT FROM GROVE OF BLUE GUM (EUCALYPTUS GLOBULUS).

The 20-acre tract averaged 80 cords per acre, the growth of seven years, from stumps of trees previously cut for fuel twice. Sprouts are appearing from some of the stumps.

A. ONE YEAR'S GROWTH.

B. THREE YEARS' GROWTH.

BLUE GUMS (EUCALYPTUS GLOBULUS) GROWING FROM STUMPS OF TREES CUT FOR FUEL.

A. EUCALYPTUS ROSTRATA AT COOPER RANCH, SANTA BARBARA, CAL.

B. EUCALYPTUS RUDIS AT MINNEWAWA RANCH, FRESNO, CAL.

EUCALYPTS GROWING SPONTANEOUSLY UNDER PARENT TREES.

issued, discussing a portion at least of the 20 to 30 species that he then recognized as remaining untreated in his Eucalyptographia. That he did not, however, expect to bring the work upon the genus to a close before his death is shown by the following: "The author can not hope during the remaining brief period of his lifetime to complete the present work with some approach to exhaustiveness of the subject." Though he continued working on the genus during much of the remaining fourteen years of his life, no additional parts were issued. The great man had devoted, with remarkable energy and enthusiasm, nearly half a century to the study of the genus, without exhausting the subject or completing a work that purported to cover it. Unfortunately the Eucalyptographia is now out of print, and it is practically impossible to secure a copy by purchase. There are probably but five copies of the work in America, with little possibility of the number ever being increased.

The fullest treatment of the genus Eucalyptus from the botanical standpoint is to be found in Volume III of the Flora Australiensis, by Bentham and von Mueller, published in 1866 by L. Reeve & Co., London. This volume contains botanical descriptions of all the species then known, 135 in number. The common colonial names of a large number of the species are given, and the part of Australia in which each species was reported as growing is stated.

Rev. William Woolls, of New South Wales, is the author of two works containing much information concerning the genus: A Contribution to the Flora of Australia; The Genus Eucalyptus, and The Plants of New South Wales. J. Ednie Brown, in New South Wales; I. G. Luehmann, in Victoria; A. W. Howitt, in Gippsland, and Walter Gill, in South Australia, have each contributed to the literature of the subject.

Mr. Joseph H. Maiden, director of the botanical gardens at Sydney, New South Wales, and Mr. F. Manson Bailey, colonial botanist, Brisbane, Queensland, are actively engaged in work upon the genus. Mr. Maiden is in a sense continuing the work of Baron von Mueller. His papers upon the Eucalypts as timber trees in Australia and upon the new species that he, in conjunction with Henry Deane, has detected, are very valuable. Maiden writes that he is at present engaged upon the manuscript of a Revisio Critica which he hopes to publish before long. Such a publication from his pen will be of incalculable value to students of the Eucalypts, and will undoubtedly do much to remove the confusion that now exists concerning the names of many species. His descriptions already published, both botanical and popular, are models of clearness, conciseness, and completeness.

The French have been prolific writers upon the culture and uses of the Eucalypts, but their articles are usually brief. Most of their publications treat especially of *Eucalyptus globulus;* some, however, are general, but only a few discuss the various species separately.

The late Charles Naudin, director of the botanical laboratory at La Villa Thuret, Antibes, was the author of two works on the Eucalypts, the first, published in 1883, entitled The Eucalyptus introduced into the Mediterranean Region;" the second published in 1891, entitled Description and Use of Eucalyptus introduced in Europe. Besides a discussion of the general characteristics of Eucalypts, they contain descriptions of the species grown about the Mediterranean, 56 in number, of which 13 were established by Naudin himself as a result of his cultural tests and his observations on the growth of Eucalypts in his region.

The most extended general treatise on Eucalypts in the French language is Les Eucalyptus, by Felix Sahut, of Montpelier. It contains a discussion of this genus, principally with reference to its geographical distribution, together with a history of its discovery; and also gives descriptions of its forest, industrial, sanitary, and medicinal adaptabilities, with suggestions regarding its culture.

Of the many other French writers on the Eucalypts, the following have treated of their culture in France: Ramel, Raveret-Watel, Planchon, Nardy, Certeux, Joly, and Combes; of their culture in Algeria, Lambert, Cordier, Bertheraud, and Trottier; in the island of Corsica, Carlotti.

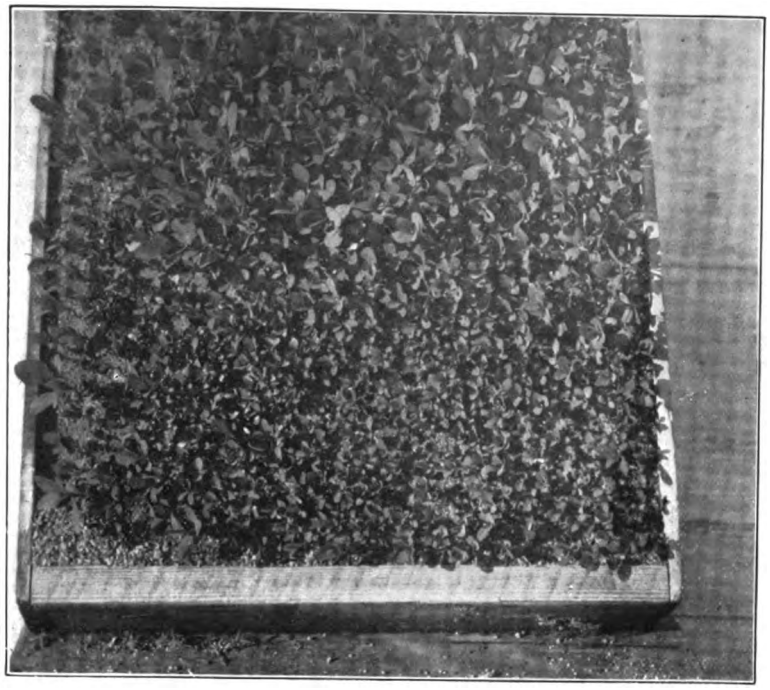
AMERICAN.

A few publications treating of the Eucalypts have appeared on the Pacific coast. The first, a compilation by Hon. Ellwood Cooper, was published in 1876. The work consisted of a popular lecture (previously mentioned) on "Forest Culture and Australian Gum Trees," by Mr. Cooper; two lectures of a similar character by Baron von Mueller; a paper by the latter upon "Australian Vegetation," and descriptions of species of Eucalypts copied from the writings of Baron von Mueller and from a seed catalogue.

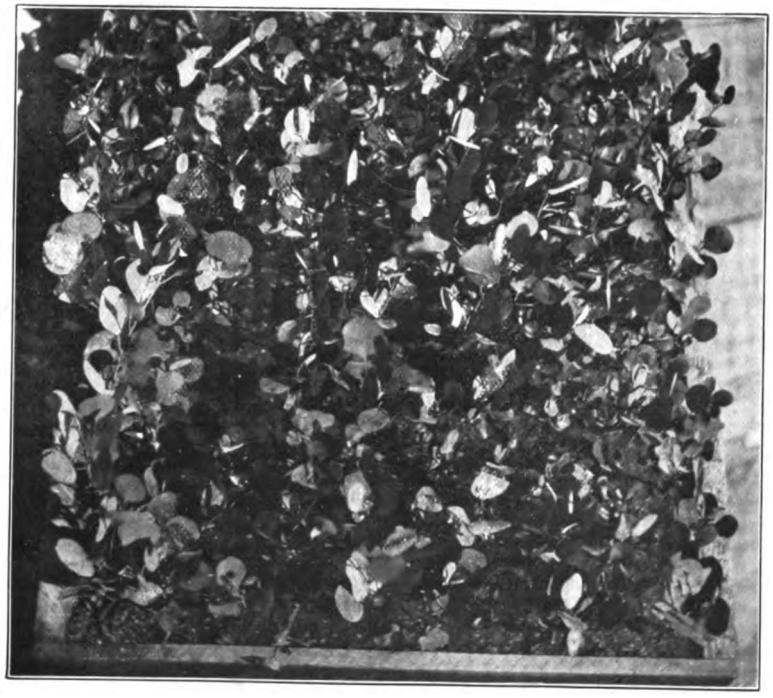
The most extensive American work on the genus appeared in 1895—an illustrated volume of 300 pages, from the pen of Hon. Abbot Kinney and the press of B. R. Baumgardt & Co., Los Angeles. This important work treats the Eucalypts from the æsthetic, the botanical, and the utilitarian standpoints. An unfortunate lack of system detracts from the usefulness of the book; but it is a mine of valuable information and suggestions. Each species that was known by Mr. Kinney to be growing in California is discussed. The work also contains directions for planting and caring for Eucalypts; the results of cultural tests of a large number of species, and the results of the distillation of the oil from 26 species; several papers by other writers upon the medicinal and chemical phases of the subject; and many useful tables and other matter from Baron von Mueller's great work. Most

of the botanical portion and many of the illustrations were contributed by the writer of this work.

Mr. J. Burtt Davy, of the University of California, contributes the article upon "Eucalyptus" in Volume II of Prof. L. H. Bailey's Cyclopedia of American Horticulture. The article contains brief botanical descriptions of 52 species, summarized from Baron von Mueller's Eucalyptographia, and "verified by reference to herbarium specimens wherever these were available." Some statements in this article concerning the propagation of Eucalypts do not agree with experience here in the Southwest, where the growing of seedlings is not a simple matter.

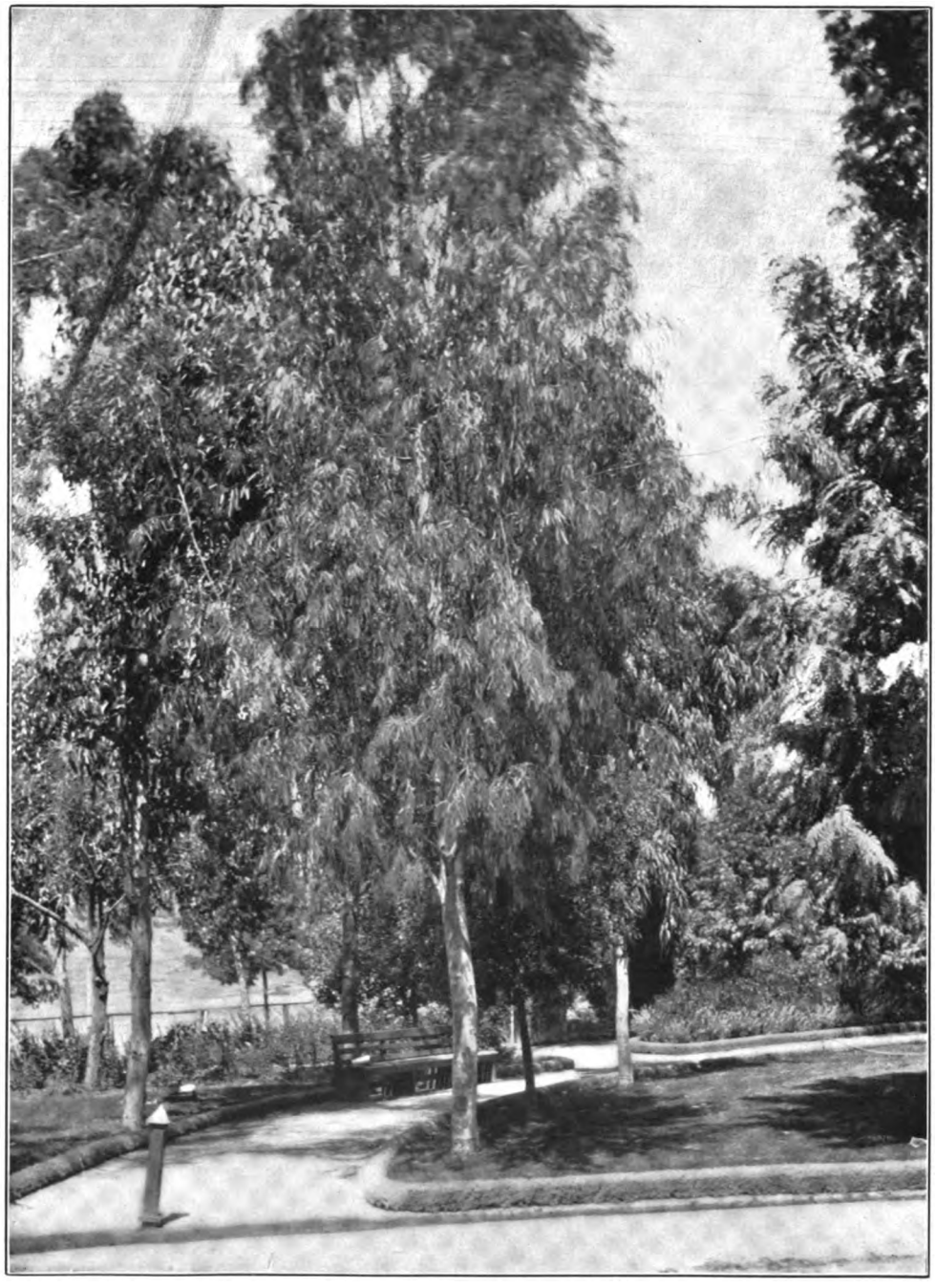


A. READY TO TRANSFER TO FRESH SOIL.

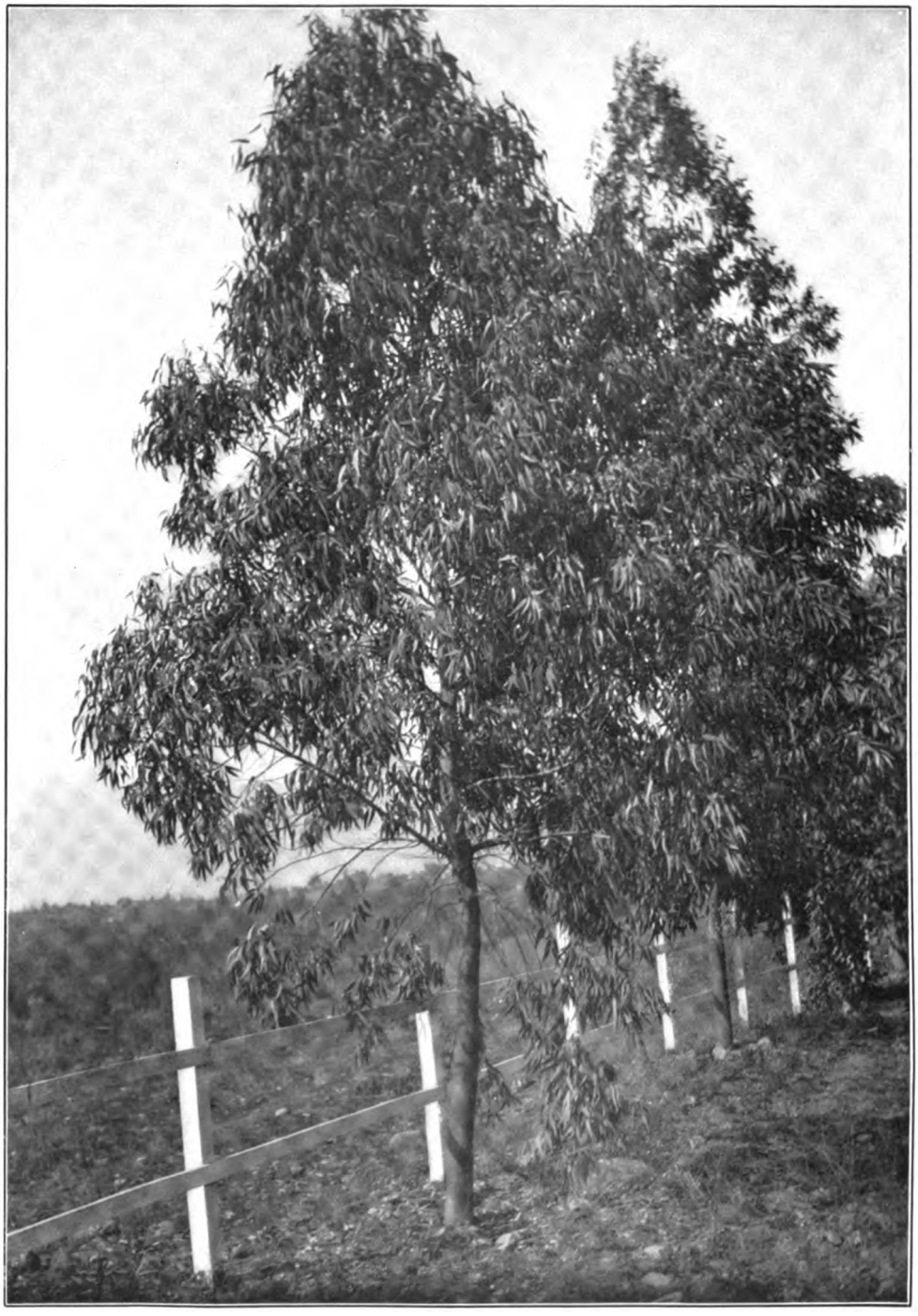


B. READY TO SET IN FIELD.

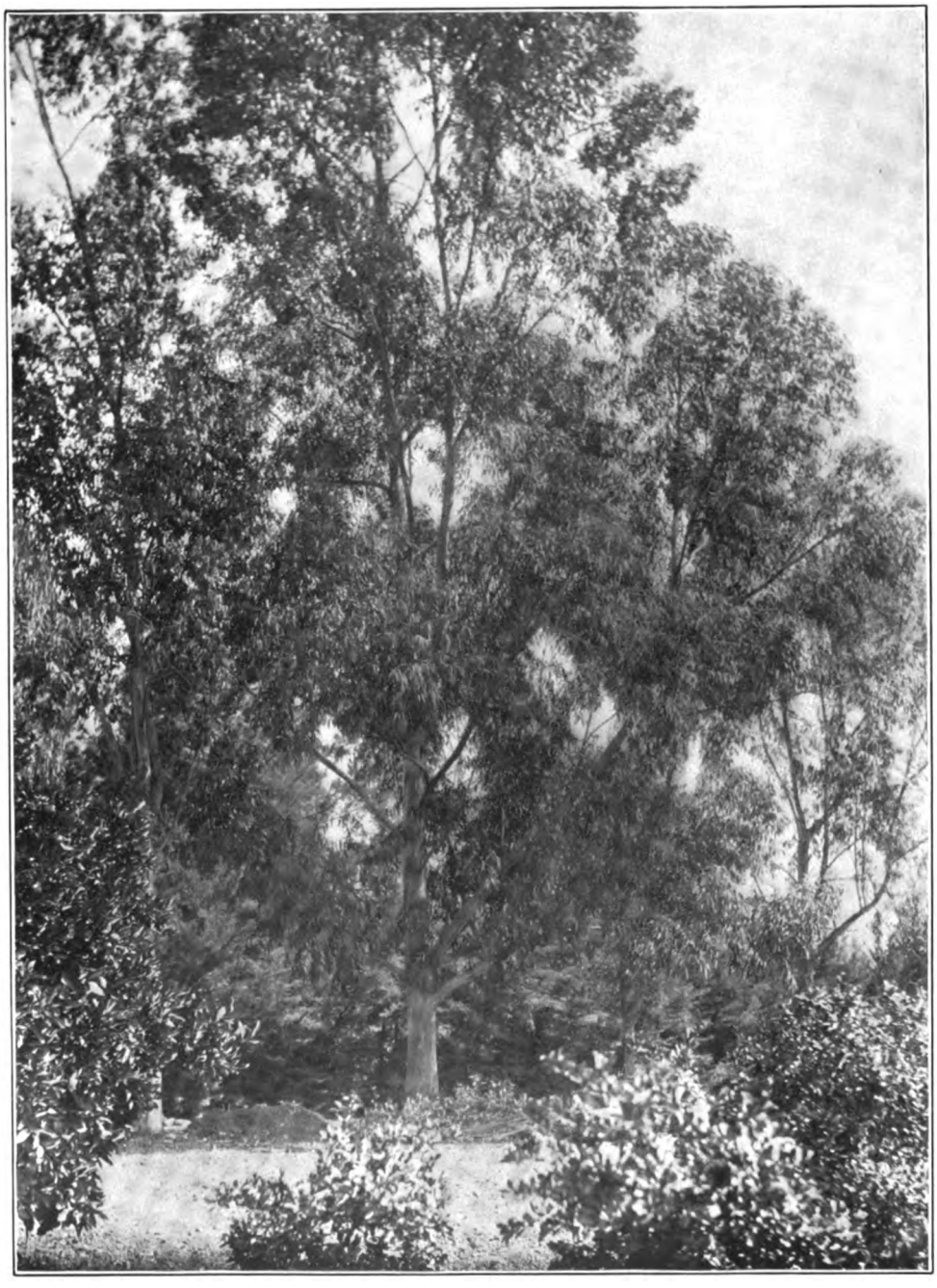
EUCALYPT SEEDLINGS IN PROPAGATION BOXES.



EUCALYPTUS AMYGDALINA, EAST LAKE PARK, LOS ANGELES, CAL.



EUCALYPTUS BOTRYOIDES. TREES 3 YEARS OLD.



EUCALYPTUS BOTRYOIDES. TREE 15 YEARS OLD.

PART II.

CHARACTERISTICS OF THE GENUS EUCALYPTUS.

GENERAL CHARACTERISTICS.

The genus Eucalyptus includes about 150 species. Most of them are trees of large size; some of them among the largest in the world. They range, however, from immense trees towering high on plains and hillsides down to small shrubs that cover desert or alpine regions.

They grow in a great variety of soils and climates, the various native environments having thus resulted in the development of species that are quite different from one another. In their native home they grow both scattered and in forests.

The Eucalypts are all evergreens, a fact that should be taken into consideration when planting them.

Many of the species are vigorous growers, a few being especially noted for the great rapidity of their growth. The Blue Gum (*Eucalyptus globulus*) is one of the fastest growing of the genus. On the ranch of Hon. Ellwood Cooper, near Santa Barbara, Cal., trees of this species 25 years old are as large as oaks whose rings show them to be 200 to 300 years old. As to their growth in France, Prof. Charles Naudin, in his memoir on Eucalyptus, published in 1891, says:

> In a score of years they (the Blue Gums) attain at least the volume and the height of an oak a century old. Some others, though not growing as rapidly, are moreover remarkable for the short time in which they may be used for carpentry, for joinery, for carriage making, for agricultural implements, for railroad sleepers, and for telegraph poles.

It is this rapidity of growth, enabling them to reach the stature of trees in a few years, that has been the principal cause of the popularity of the Eucalypts where they have been introduced.

Most species if pruned, or if cut off at the ground, sprout freely, sending up shoots that usually make a very vigorous growth. This makes it possible to cut the trees for fuel, for timber, or for other purposes, and in a comparatively short time to again have a forest containing as much timber as before the trees were cut. A Blue Gum (*Eucalyptus globulus*) 8 to 10 years old, if cut to the ground, will send

up shoots that will reach a height of 75 or 100 feet in from six to eight years. Several other species make an almost equally rapid growth after being cut. The cutting may be repeated every few years for an indefinite period.

Eucalypts are propagated only from seed. To this fact is due their comparative freedom from injurious insects and from diseases usual to exotics which have been introduced into America by cuttings or seedlings. Their dissemination throughout the world having been by seeds alone, the insect enemies and the parasitic fungi of their native home have been left behind. In America they have few insect enemies, and they are remarkably free from disease.

THE TRUNK.

The character of the trunk varies considerably. Of many species the trunk is erect and straight-grained; of others it is more or less curved and twisted. In the majority of species the trunk diminishes in size upward very gradually, being long and cylindrical. It is this characteristic that makes many of them so admirably adapted for masts, piles, bridge timbers, and telegraph poles.

The bark of the different species shows great variety. In some it is very rough, while in others it is quite smooth. In many species its character changes considerably with age. The bark of all seedlings is smooth, that of some remaining so permanently, that of others becoming more or less rough and furrowed as the tree grows older. Some rough barks are fibrous and stringy on the outside, while others are hard and brittle. Trees having the former kind of bark are commonly known as stringy-barks; those having the latter, as iron-barks. Intermediate between the above two types is a bark, somewhat fibrous, but more or less scaly on the outside, like that of the American Ash. Of several species the bark of the limbs is much smoother than that of the trunk; and often, in the same species, the surface of the bark varies considerably, being modified by the soil and climate. The bark remains permanently on the trunks and limbs of some species, while from others the outer layer falls away freely in sheets or strips, leaving the fresh surface smooth and lighter in color. The surface of the bark of different species varies in color from light cream to dark brown.

The matured wood of all species is hard—of some species very hard. Of many species it is tough and durable, resembling in this respect the wood of American oaks and hickories. The wood of some species is heavier than water. The wood varies a good deal in grain, being straight-grained and easily split in some species, while in others it is gnarled and splits with great difficulty. For this reason the various species furnish timber adapted to a great variety of uses. The color of the wood varies from clear white to a rich brown.

THE FOLIAGE.

The Eucalypts present great variety in the appearance of their foliage. Of some species it is bluish, of others a light or grayish green, and of still others a very dark green. Of some the foliage is dense, but of many species it is open, affording but little shade. The foliage and young twigs of all species possess a more or less pronounced odor, due to the presence of oil-dots. To the majority of people the odor of most species is agreeable—in some cases quite fragrant.

Of many species the leaves of the young seedlings are of a different shape from those of the adult tree. As a rule, the leaves of the seedling tree are broader, shorter, and shorter-stemmed than those of the older ones. As the tree grows older, the newly formed leaves are commonly successively longer and narrower, until the adult form is reached. This change usually occurs during the first year or two of the tree's growth. The leaves of some species are opposite on the stem of the young seedlings, becoming scattered as the change to the adult leaf-form occurs. Only a few species have permanently opposite leaves. These marked characteristics in seedling leaves furnish one means of identifying species. A grower or purchaser of young Eucalypts, if he knows what the nature of the leaves should be, can distinguish the species very early in their development. It is for the purpose of furnishing assistance on this point that the illustrations of seedlings are given in this publication. (See Pls. LXXXI to LXXXIX.)

The mature leaves of most species are comparatively long and slender, the prevailing shape being that of a lance, or somewhat curved like a sickle. They vary considerably as to texture, those of some species being thin and papery, while those of the majority are more or less thick and leathery. Instead of spreading horizontally and being darker colored above than below, as is the case with most flat-leafed trees, the leaves of the majority of species present one edge to the sky, the two surfaces consequently having the same or nearly the same appearance. Those species with leaves spreading horizontally naturally furnish more shade than those whose leaves hang with one edge skyward.

THE BLOOM.

The Eucalypts bear flowers that are more or less conspicuous. The flowers of different species differ sufficiently to render very material help in deciding upon the correct name of a tree. The greatest differences are in the flower buds, which, just before they open, are much more useful in determining the species to which a tree belongs than the open flowers. Most species bloom freely and many bloom very profusely. The trees of most species produce flowers early in their development, blossoms sometimes appearing on 2 or 3 year old

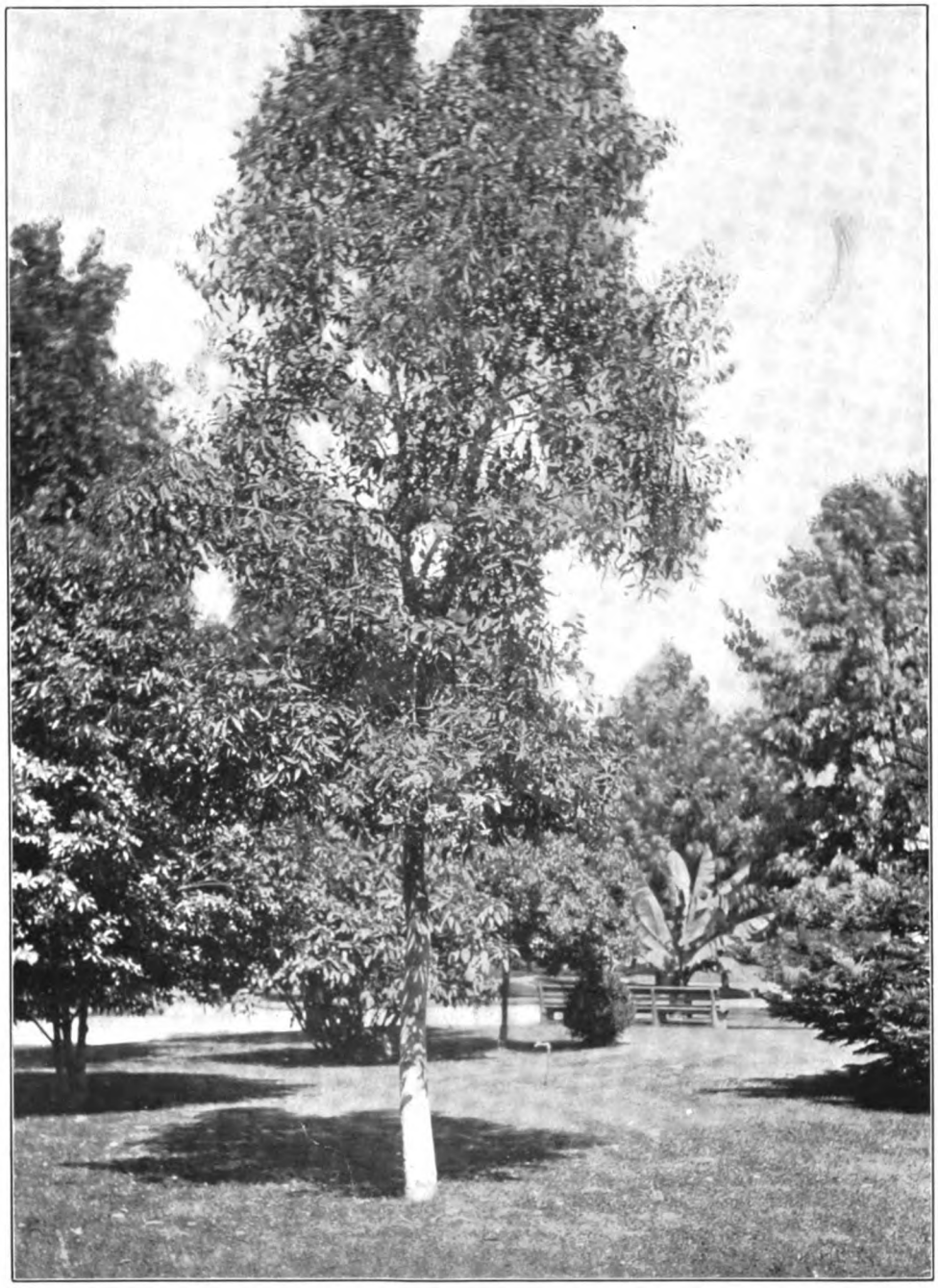
trees that attain, when full grown, a height of 100 to 300 feet. This early blooming greatly facilitates their identification and their propagation from seed. The flowering periods of the different species vary considerably, extending through the entire year. Some species remain in blossom a large portion of the year, some bloom during two distinct periods of the year, while of others the flowering season is quite limited.

The flowers usually grow in clusters, which botanists call umbels, rarely singly. The clusters are borne at the leaf axils or at the ends of branches, usually singly; but in some species several clusters are found arranged in what botanists call a panicle. The unopened flower buds are hermetically sealed by a close covering that corresponds to the outer leaves, or calyx, of most other flowers. It was this close covering of the flowers that suggested to L'Hertier, the botanist who discovered and named the genus, the name Eucalyptus, the word meaning in Greek "well concealed." As the flower opens, the upper part separates as a lid and falls away, while the lower half of the calyx remains permanently and incloses the developing seeds. At the same time there falls away a less conspicuous under covering that is thought to correspond to the petals of other flowers. The flowers when open, therefore, are destitute of any enveloping flower leaves. The stamens constitute the most conspicuous feature of the opened flowers, being usually very numerous. They differ considerably in color, the prevailing tint, however, being greenish or yellowish white. Of some species the stamens are highly colored, thus causing the flowers to be strikingly beautiful, and consequently highly prized for ornament.

THE SEEDS.

The persisting portion of the calyx becomes a firm, tough covering for the seed case, which endures much weathering and usually remains on the tree for a considerable period. The seed cases of the different species vary in size from one-eighth of an inch to 1 inch in diameter. The shapes are various, the prevailing forms being that of a cup, a goblet, a top, or an egg. As the seed cases mature the upper covering separates into from three to five tooth-like bodies termed valves, and the seeds fall out between them. The valves when open either project from the mouth of the seed case or are included in it. The shape of the seed case and the position of the valves peculiar to each species furnish valuable data for determining the name of a Eucalypt.

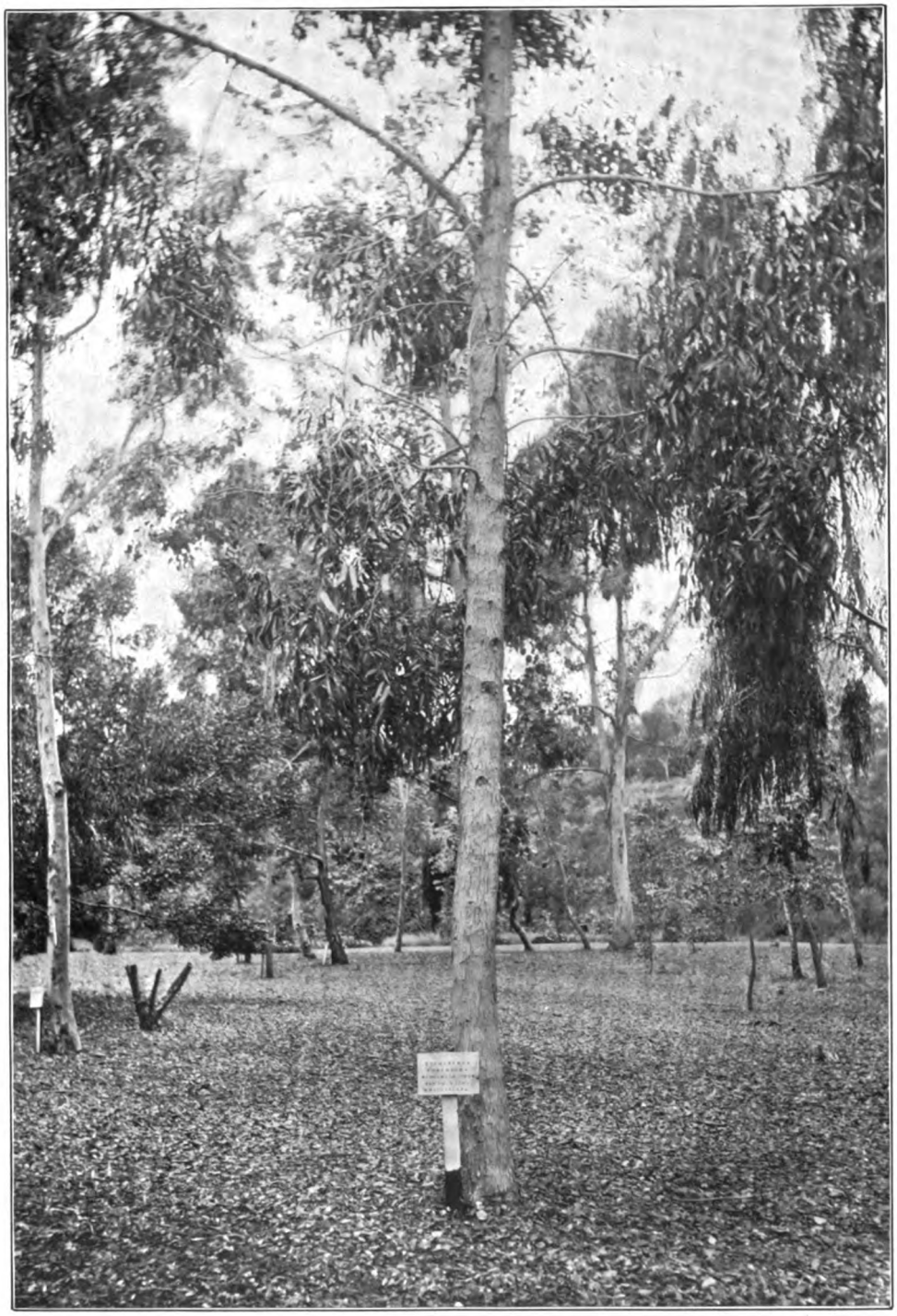
The seeds are, with a few exceptions, quite small and very numerous, many, however, usually being infertile. The smallness of the seeds (the usual length being 0.04 to 0.1 inch) makes their transportation easy and the rearing of young plants on a large scale practicable. The number of young plants that the seeds of a single tree would produce per year is enormous.



EUCALYPTUS CALOPHYLLA, EAST LAKE PARK, LOS ANGELES, CAL.

EUCALYPTUS CITRIODORA—TALL FORM. TREE 15 YEARS OLD, COOPER RANCH, NEAR SANTA BARBARA, CAL.

EUCALYPTUS CITRIODORA—SPREADING FORM. TREES 20 YEARS OLD, COOPER RANCH, NEAR SANTA BARBARA, CAL.



EUCALYPTUS CORYMBOSA, STATE FORESTRY STATION, SANTA MONICA, CAL.

RELATION OF THE EUCALYPTS TO CLIMATE.

GENERAL CLIMATIC REQUIREMENTS.

The Eucalypts differ considerably as to the climatic conditions under which they thrive, but all the larger arboreal forms agree in requiring a warm climate. Not only do they prefer a climate that is equable, but other conditions must exist in order that they may be grown successfully. Prof. Charles Naudin, in his memoir on the genus, gives quite concisely the conditions required for the successful growth of Eucalypts. He says:

> The first condition of success in the culture of Eucalyptus is a climate appropriate to their nature; that is to say, for a great majority of the species, warm summers, a moderate amount of rain, a certain atmospheric dryness, plenty of sunlight, and very temperate winters.

While all thrive best in regions with warm summers, many species do not endure the summer heat of certain sections of southwestern North America. Regions where the midsummer maximum temperatures range from 80° to 105° F. are best suited to the growth of these trees. Some species thrive in regions where the maximum temperatures range in summer from 100° to 120° F., but the number is limited. The various species differ very much as to the amount of cold they will endure. Some will stand minimum temperatures of 10° to 15° F., while other species will under no circumstances endure temperatures much below freezing. The degree of cold that any species will endure depends not only upon the other conditions of the atmosphere at the time, but upon the nature of the weather that has preceded. Low temperatures following a warm period that has stimulated growth do much more injury than the same degree of cold following a gradual fall in temperature.

While most Eucalypts are benefited by occasional heavy rainfalls that saturate the soil thoroughly, frequent rains and a very humid atmosphere are not conducive to their healthful growth. They have the power of absorbing great quantities of water by means of their roots, but the above-ground parts of most species prefer to be in quite dry atmosphere, at least for a portion of the year. A few species grow in swampy, humid regions, but the majority of them prefer drier situations. Plenty of sunlight is quite essential to the healthy growth of most species, few of them thriving in the shade of other trees or in regions having much cloudy weather.

CLIMATIC AREAS IN NORTH AMERICA.

With regard to the effect of climate upon the Eucalypts, we may divide the United States into four sections. In the first and largest division the winters are ordinarily so cold as to kill the Eucalypts, and their growth there outdoors is consequently impracticable. This

region comprises all of the United States except a strip varying from 100 to 300 miles in breadth along the southern and the southwestern border.

In the second division the winters in most years are so mild that growth is not checked; but during some winters a cold wave passes over the region that kills the whole, or a large part of the tree that has grown during the years in which no unusually cold period occurred. In this section Eucalypts never, or rarely, become dormant; and when a cold wave comes they are unprepared for it, the result being disastrous. This region consists of Florida and the adjacent coast region of the south Atlantic and the Gulf of Mexico. In Florida the conditions seem to be especially trying. Col. G. H. Norton, of Eustis, Fla., writes, under date of February 6, 1900:

> All Eucalypts do well, but are killed to the ground when a very severe blizzard comes and the mercury falls much below 20° F. The trouble with the climate is, we have warm weather nearly all the time in winter, with an occasional cold wave.

Possibly there may be a species as yet untried there that would withstand the conditions described.

In the third division the minimum temperatures, while commonly quite low during midwinter, decrease so gradually during the latter part of autumn that the growth of the previous year has time to mature. It is thus able to endure a low temperature that would be fatal in the second division, discussed above, where the weather is alternately warm and cold. In other words, these evergreens, in common with the others of the region, both native and exotic, become dormant, just as native evergreens do in the colder first division. For this reason many Eucalypts can be grown there that can not be successfully grown in the second division, even though the mean temperatures of the winter may be higher in the latter. This region consists of the interior valleys of part of Texas, of southern New Mexico, of southern Arizona, and of southern California. In much of this region the summers are so dry and hot that many Eucalypts can not endure them. Consequently, the species that thrive in this section are those that both endure a very dry, hot atmosphere and become sufficiently dormant during the winter to endure the low temperatures that occur. The species of which this is known to be true are *Eucalyptus rostrata*, *E. rudis*, *E. leucoxylon*, *E. hemiphloia*, *E. polyanthema*, *E. melliodora*, *E. corynocalyx*, *E. tereticornis*, and *E. salubris*.

In the fourth division the climate is so equable that nearly all species of the genus Eucalyptus will grow in it. In this region the mercury rarely falls below 25° F. during winter nor rises much above 105° F. during summer, and the atmosphere is commonly moderately humid. This division consists of the coast region of central and southern California. It is the section of the United States in which Eucalypts are grown most extensively and most successfully.

Mexico might be similarly divided into four Eucalypt areas. The territory of these divisions would not necessarily be contiguous, but would be determined by elevation rather than by latitude or longitude.

USES OF EUCALYPTS.

The Eucalypts probably serve more useful purposes than the trees of any other genus grown on the globe, except, possibly, the various palms. Their uses are very diverse. As they grow they serve as a forest cover to mountains, hills, plains, and swamps, as wind-breaks, and as shade trees. While growing they are also the source of many gums and resins, and of honey. When cut, they furnish valuable timber, excellent fuel, and a very useful oil. Besides all this, many of them are ornamental, and they have the reputation of improving the climate of the region in which they grow. Being hardwood trees, they serve the useful purposes that hardwood trees ordinarily serve, and besides furnish many useful products similar to those obtained from a variety of other trees, and from shrubs and herbs. This great variety of uses is made available, in regions where they have but recently been introduced, by reason of their very rapid growth, it being possible to enjoy many of their uses while the trees are still standing, and to obtain from them many useful products within a very few years after planting them.

AS A FOREST COVER.

It is as forest trees that the Eucalypts are most useful; planted as ornamental or as shade trees they are often disappointing. Planters who have put them out as forest trees are the ones who have derived the greatest benefit from them. (Pl. I, A.) Hon. Ellwood Cooper, of Santa Barbara, was one of the first Americans to recognize the prospective value of Eucalypts as forest trees. He acted upon his conviction, and has for a score of years been reaping the reward. Besides enjoying the beauty and shade of his groves, as well as the beneficial changes they have wrought in the climate of the region, he has for many years received from them an annual income of no inconsiderable amount. Those who have planted them singly or in small groups as ornamental or shade trees have received little or no financial return, and have in some cases been disappointed in them because not serving, as they had hoped, the purpose for which they were set.

In many of the semitropic portions of the globe the Eucalypts are the trees most suitable to plant for forest cover. Much of the treeless land of semitropic America might be covered with these trees. As the conditions under which the different Eucalypts grow in Australia are very diverse, it is evident that, if the species are properly selected, they will cover nearly all kinds of situations.

The species suited to particular localities or conditions may be ascertained by reference to pages that follow. Those that grow in Australia on the uplands and in other dry situations can be used here to cover similar regions. In the Southwest there are large areas of hilly country, of little or no use for other purposes, that might be transformed into useful forests by covering them with these trees. This covering of the hills with forests will not only furnish shade, a source of honey, and a supply of fuel and timber, but will prevent the too rapid run-off of rain water, which results in the cutting and washing of hillsides and in other forms of damage below. On this point Mr. Cooper, in a letter to the writer dated June 18, 1900, says:

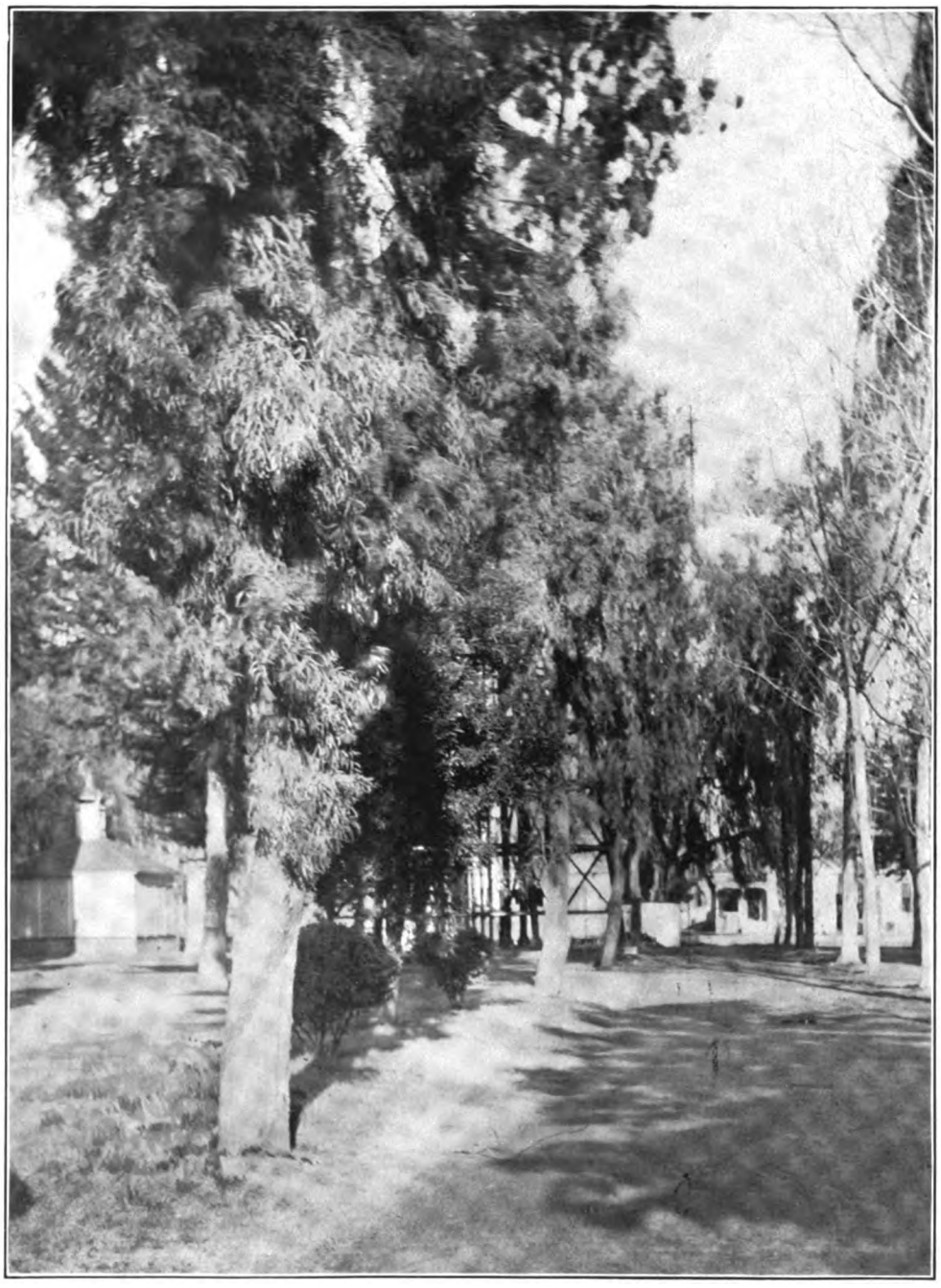
> South of where I live, about one-eighth of a mile, is a steep hillside. I noticed during my residence the first years that heavy rains washed down the soil, all the rain running off. I planted Eucalyptus trees on this hillside, about 4 feet apart. When these trees had four or five years of growth we had a tremendous rain storm, 14 inches of rain falling in four days. Nearly all this water was held by the trees, practically none running off. There is always more moisture in the soil near these trees than some distance off. There is no question as to the great importance of having our mountain sides well wooded with trees and bushes to preserve the rain for the benefit of the valley below.

The Eucalypts can be utilized as a forest cover for mountains as well as hillsides. Several species grow naturally upon the mountains of Australia. These will serve as a covering for bare mountain sides in the Southwest, and the writer believes that they would prove quite valuable for recovering those that have been denuded of their natural forests by fire. The rapid-growing species, less resistant to frost, could be planted on the lower parts of mountains, and the somewhat slower-growing, more hardy ones farther up the mountain sides. Those adapted to alpine situations may be planted to a height of from 4,000 to 6,000 feet.

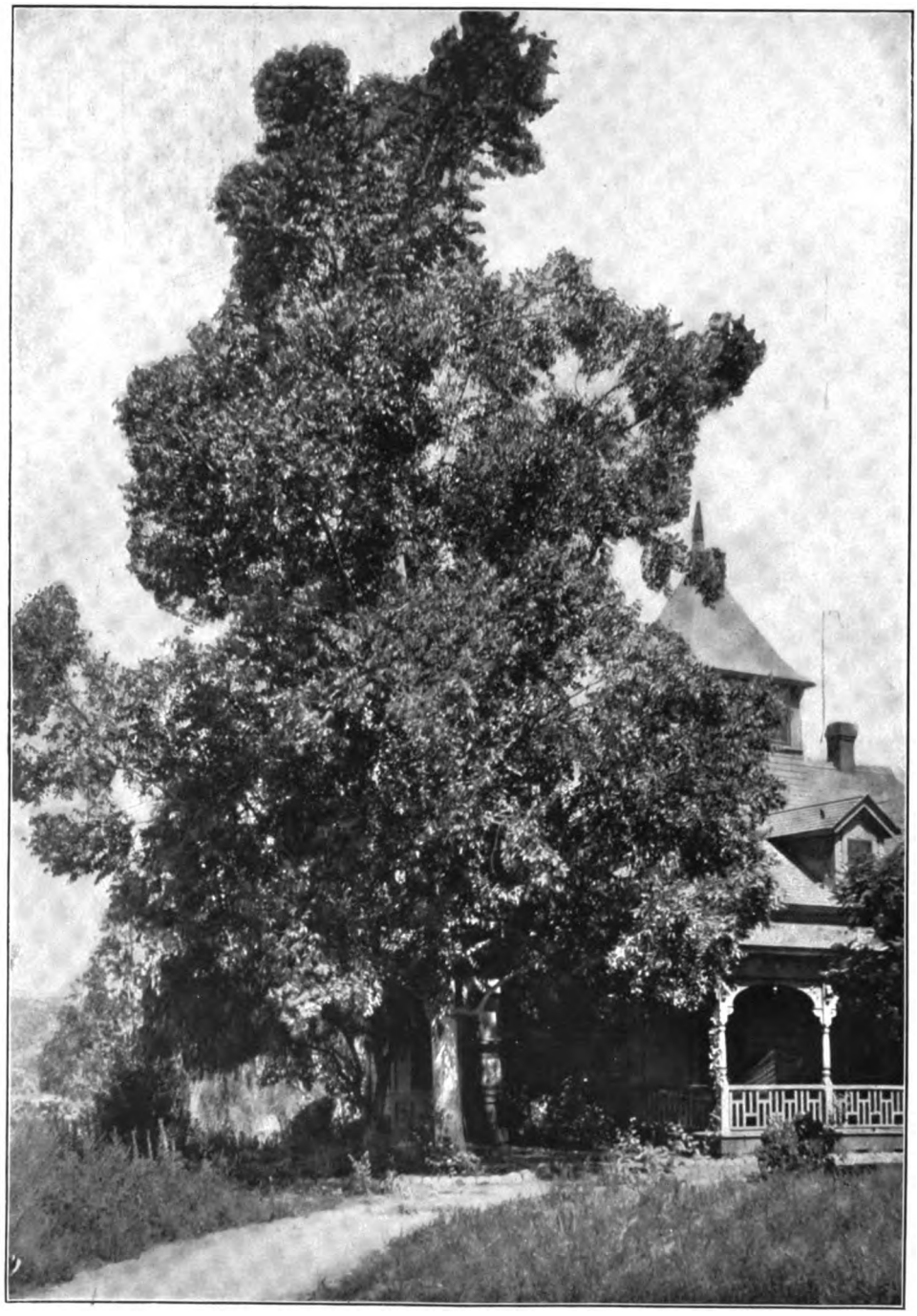
Lowlands, too, may be covered with Eucalypts. In Australia several species grow naturally in swamps or other low situations. These may be utilized for covering the lowlands in warm regions in other parts of the world, thus reducing the amount of the stagnant water, and in other ways rendering such localities more agreeable.

Judging from observations made during the past few years (the most trying years upon vegetation that have been experienced in the Southwest since it was settled), the writer believes that much of the treeless desert region might be forested with Eucalypts. At the close of the season of 1900, the driest one of which the Weather Bureau has a record, trees of several species were observed growing without irrigation in southern Arizona, and some of them had not been irrigated for many years. Trees of the Red Gum (*Eucalyptus rostrata*), the Sugar Gum (*E. corynocalyx*), and of *E. tereticornis*, growing in a neglected tract under desert conditions where the ground water was about 100 feet below the surface, endured the above trying summer. This

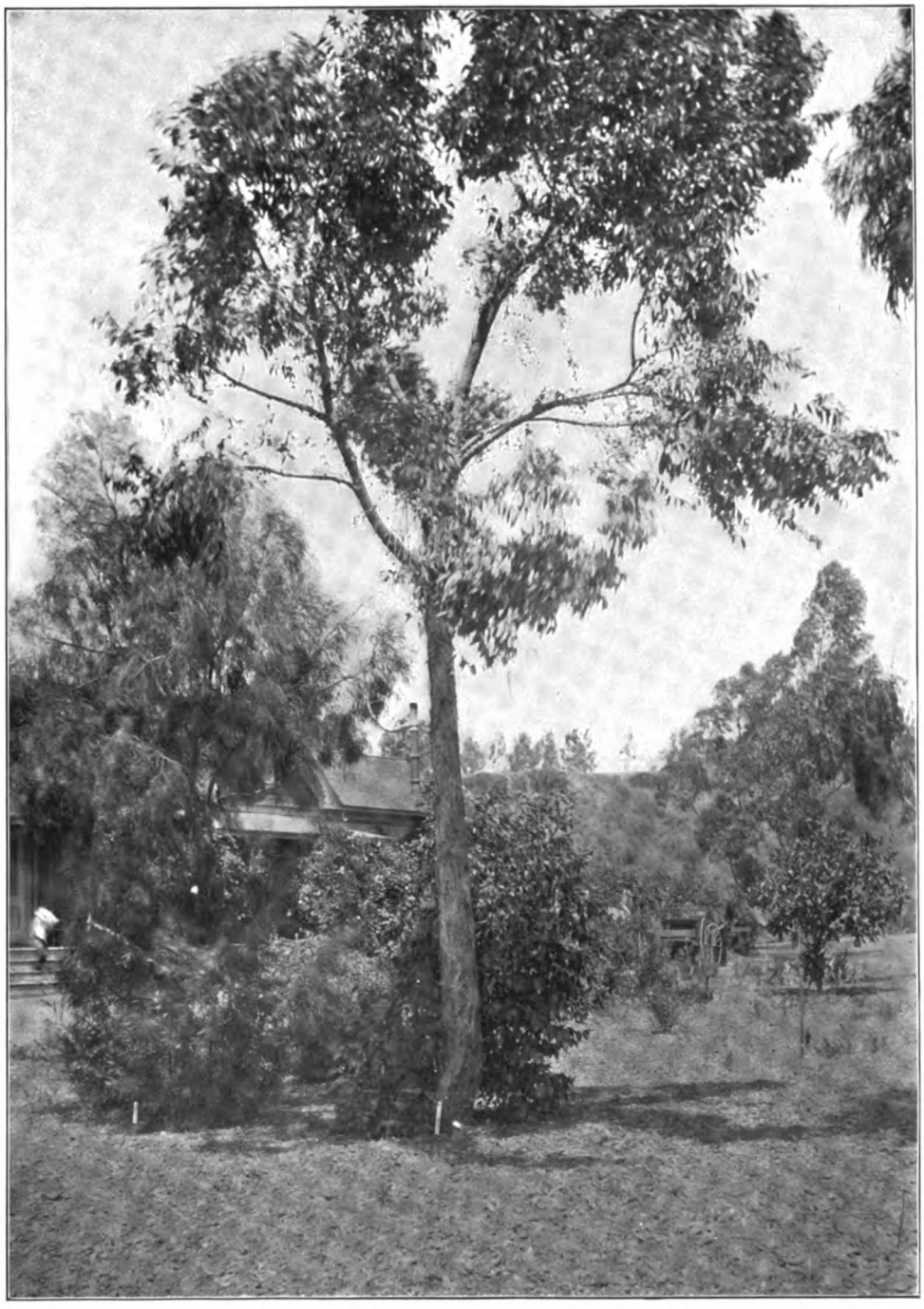
EUCALYPTUS CORYNOCALIX, SHOWING TRUNKS SUITABLE FOR FENCE POSTS.



EUCALYPTUS CREBRA, COURT-HOUSE GROUNDS, FRESNO, CAL.



EUCALYPTUS DIVERSICOLOR, NEAR SOUTH PASADENA, CAL.



EUCALYPTUS EUGENIOIDES, STATE FORESTRY STATION, SANTA MONICA, CAL.

indicates that these, and probably other species, might be used as a forest cover for similar desert regions. In order to get the seedlings started it would be necessary to water and cultivate them a year or two, after which they would be supported by the rainfall, especially in localities where the ground water is near the surface.

AS WIND-BREAKS.

In the Southwest the Eucalypts have been found very useful as wind-breaks. Their quick growth and varied habit make them peculiarly adaptable for this purpose. Thus a low tree with dense foliage may be selected where a low, close wind-break is desired, and a taller species where a higher and less dense shelter is needed. Owners of orchards, especially citrus orchards, have found them particularly beneficial as a break to the strong winds and a protection during cold weather. (Pl. I, B.)

On this point Mr. Nathan W. Blanchard, of Santa Paula, one of the most extensive growers of citrus fruits in California, in a letter dated June 11, 1900, makes the following statement:

> In reference to Blue Gum wind-breaks, I prefer them to any other. They grow rapidly and break the force of the wind, which is what is required. A solid wind-break like a Monterey Cypress, the wind sometimes falls over and has a twisting effect on the trees, similar to wind coming from a high mountain range. With my experience in this valley I would plant the wind-breaks about 450 feet apart.
>
> The Limoneira orchards are laid off in sections, putting the Blue Gums 40 rods apart, but I think this distance is too great and it is too far to run the water economically. My wind-breaks are about 450 feet apart, and are so effective that one does not feel the wind at all among the orange trees. Neither is my fruit in the least impaired by the wind, however strong it may blow down or up the valley. My orchard ditches are along the wind-breaks, and the trees therefore get all the water that they need and do not draw upon the moisture of the orchard to the detriment of the fruit trees. Indeed, I have some orange trees alive that are growing right under the Blue Gums, bearing some good fruit. If the Blue Gums are sufficiently supplied with water they have no injurious effect upon the trees other than the shade, and on the east side of the wind-breaks my trees are more thrifty, or at least bear more fruit, than the average, while on the west side the shade is somewhat detrimental to the amount of fruit that I secure.

Upon the above subject Mr. Ellwood Cooper, of Santa Barbara, in the letter previously mentioned, writes as follows:

> The fruit orchards where protected have larger growth and cleaner leaves and stems. Less fruit blows off during high winds. I know of an orange orchard at Santa Paula where Eucalyptus trees were planted on the east and west sides—quite a distance between. The trees on either side, where protected, were twice as large as those in the center; in fact the orchard was sloping from the protected sides to the center. The center rows were taken out and Eucalyptus trees planted. The orchard now shows a uniform appearance.

Mr. Cooper also speaks of the value of the Eucalypts as a wind-break for grain fields. On this point he says:

> In wheat and barley farming I found that in the immediate vicinity of the groves

of Eucalypti there was a much heavier crop and taller straw. Near the ocean, where the trees protected the grain from sharp sea wind, there was certainly more than twice as much grain and twice as much straw. The unprotected grain had over one-third to one-half the heads blasted—no grains in the injured parts. The straw had a rusty appearance. From facts actually established I have made the statement that three-fourths of an area will produce more grain or fruit with the other fourth in forest trees than four-fourths without the forest trees; hence the great economy in tree planting.

The last statement would not apply to all regions, but of those swept by heavy winds it is undoubtedly true. There are large areas in Ventura County, Cal., that would not be tillable but for the Eucalypts. Part of the land is so sandy that formerly it was blown about by the wind, and not only the crops growing in it, but those of adjoining fields were seriously damaged. The planting of Eucalypt wind-breaks has so moderated the wind velocity that now little damage is ever done by it.

Many fruit growers in southern California believe that wind-breaks of Eucalypt trees protect their orange and lemon orchards from frosts. The question was a subject of discussion at a large horticultural meeting held in that section April 29, 1901. In the Los Angeles Times's report of the meeting is the following:

Four hundred people, representing ten farmers' clubs, met Monday at the ranch of George Turner, near Cucamonga, to study the system of wind-breaks established there as a protection against frosts. The visitors were seated among the Eucalyptus trees which they had come to study. "Frosts in relation to wind-breaks" was the subject of a paper by John Hoffman, of Cucamonga. In stating the results of his investigations he said "the temperature is usually higher on the north side of a wind-break than on the south side," and that, since his orchard had grown large, "the ground had frozen but once, and that was at a distance from the wind-break."

AS SHADE TREES.

While many of the Eucalypts are not especially desirable shade trees, the fact that they will grow well in many situations where other trees make poor growth, or will scarcely grow at all, gives them considerable value for this purpose. They are especially suitable for country roads, for the vicinity of barns and other farm buildings, and for shade in pastures. As road shade trees, many species have proved very useful in the Southwest and have been much used for this purpose. (Pl. II, A, B.) Mr. Cooper, in the letter already mentioned, writes upon this point as follows:

The public highway through my ranch, seven-eighths of a mile in length, has a double row of trees on either side. There is less mud in winter and less dust in summer than on the road at either approach.

The writer observed the latter fact while there during August. In regions where there is less sunshine and more rainfall than there is at Santa Barbara it might be well to plant the trees farther apart on the sunnier side of the road to permit the road to dry after rains. In many

cases the trees can be so set along the road as to serve both as a windbreak against the most disagreeable winds of the region and as shade trees during summer. (Pl. III.) In all cases the fact that these trees are evergreen, and consequently shade-producing both winter and summer, must be taken into consideration. In regions where heavy winter rains occur it would not be wise to plant Eucalypts so thickly as to keep the road from drying.

In many parts of the Southwest the Eucalypts are utilized to advantage to furnish shade in pastures. If set along the fences and along irrigating ditches they can be made to protect the animals in the pasture without at any time interfering with farming operations. In the place of the Cottonwood and other deciduous trees, some Eucalypts would be an improvement, both in appearance and in usefulness. Even during the winter, when deciduous trees are leafless, there are many days when animals in the pasture need shelter from the sun, and many more when protection against wind and rain is needed. The Eucalypts would furnish this protection to animals. In addition they would be a source of better fuel and timber than most deciduous trees, and would add much to the appearance of the winter landscape.

AS A SOURCE OF TIMBER.

For Australia and the neighboring islands the Eucalypts are one of the important sources of the general timber supply, and are the chief source of the hard-wood timber used there. The uses made of Eucalyptus timber are remarkably diverse. It enters into the construction of buildings, ships, bridges, railroads, piers, telegraph lines, fences, paving, vehicles, agricultural implements, furniture, barrels, and a great variety of minor articles. In his Notes on the Commercial Timbers of New South Wales Mr. Maiden names twenty-five "special purposes" for which the timber of Eucalypts is used in that colony. Six species are named as valuable for bridge timbers, five as valuable for piles, nine for paving, eight for posts, three for railroad ties, four for railway coaches, five for lumber and shingles, seven for the various parts of vehicles, two for barrels and casks, and two for broom and tool handles. Eleven "special purposes" are assigned to the timber of the Spotted Gum (*Eucalyptus maculata*), ten to the timber of the Ironbark (*E. sideroxylon*), eight to that of Red Mahogany (*E. resinifera*) and Tallow Wood (*E. microcorys*), six to that of Gray Gum (*E. propinqua*), five to that of Red Gum (*E. rostrata*), and a lesser number to that of seven other species. Not only in Australia is the timber of Eucalypts used thus extensively, but it is exported in large quantities, the bulk of the hard-wood lumber shipped being from these trees. R. Dalyrimple-Hay, in his work entitled The Timber Trade of New South Wales, names thirteen species that furnish timber for export. He gives the annual output of lumber from the 108

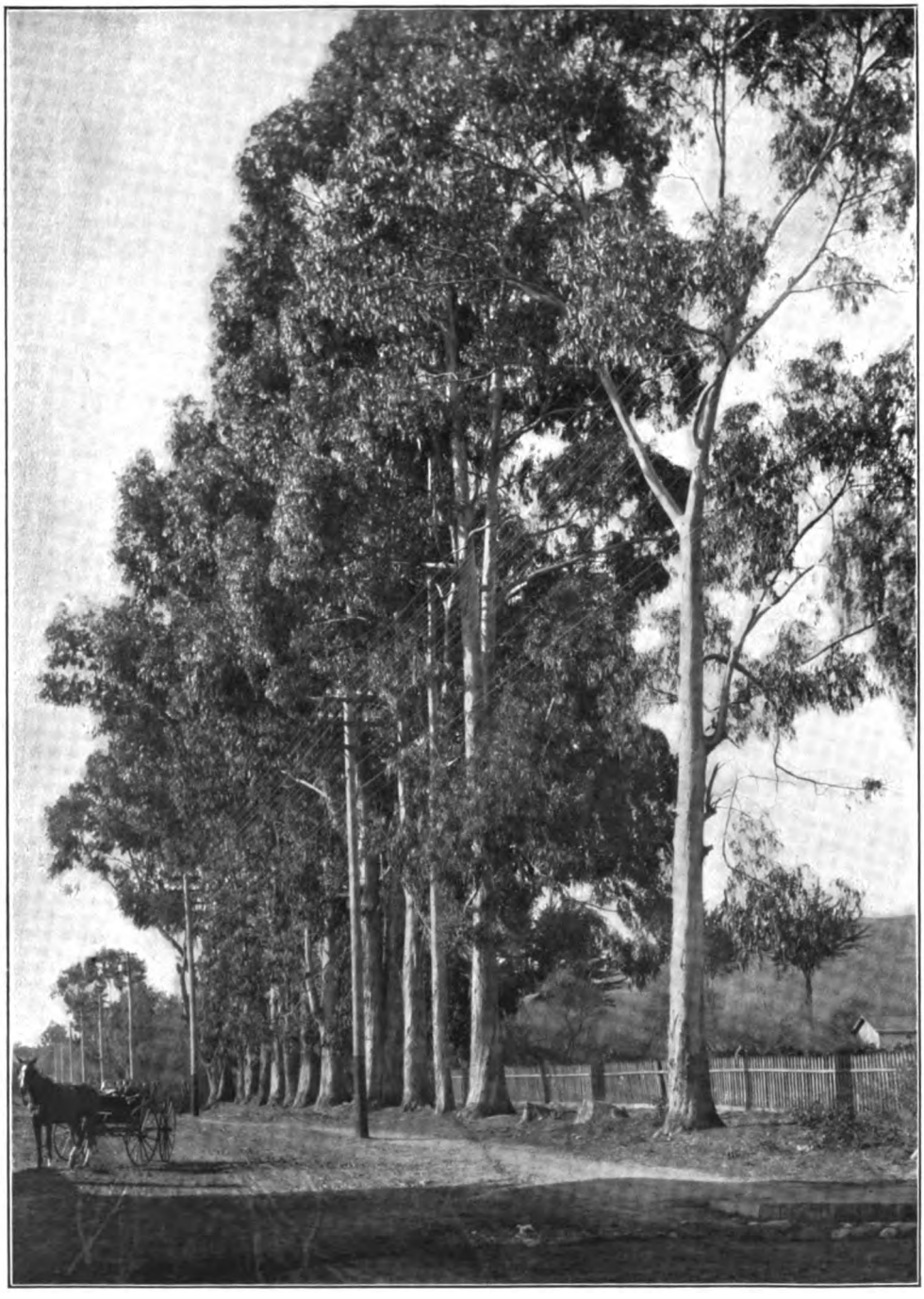
mills of the colony as 59,500,000 superficial feet, a large part of which is from Eucalypt trees. Shipments are made to distant parts of the globe, including Africa and even England.

The timber of different species of Eucalypts differs very much in character. While that of all species is hard wood, the degree of hardness, the strength, durability, flexibility, color, and many other qualities are quite different. Great differences exist also in the timber of the same species grown in different soils and climates. To these variations is due, largely, the great variety of uses that the timber of these trees serves.

In America the Eucalypts have not yet been grown long enough nor extensively enough to have become a source of lumber. The principal uses made of the timber thus far are for fuel, piles, posts, and some of the parts of farming implements, and for pins for insulators on long-distance transmission cables. The species used most for piles in southern Australia does not thrive in the Southwest, but the Blue Gum has been found to be a very durable substitute. (Pl. IV, A.) The life of Redwood (*Sequoia sempervirens*) and of Oregon Pine (*Pseudotsuga taxifolia*) piles is from four to seven years on the Pacific coast. Blue Gum piles last twice as long. The piers at Santa Barbara and at neighboring sea towns are maintained with piles of this Eucalypt. Mr. Cooper informs the writer that he has sold from his groves nearly $10,000 worth of piles during the past ten years. At Oceanside the superior value of Eucalypt piles is reported to have been demonstrated through the surreptitious acts of a contractor. Lacking a few piles of the timber specified in the contract (Oregon Pine), he is said to have obtained some Blue Gum timbers from the vicinity and to have ordered the night crew to place them on the inside, where their presence would not be detected. When it became necessary to repair the pier a few years ago some sound piles were found among others nearly destroyed, and upon examination they proved to be the Blue Gum trees. The demand for these piles is now greater than the existing groves of Eucalypts can supply. It seems probable that piles may become one of the important crops grown by farmers of the Southwest. As the trees now planted become larger, and as planting becomes more extensive, the Eucalypts will undoubtedly become sources of much timber for a great variety of purposes. (Pl. IV, B.)

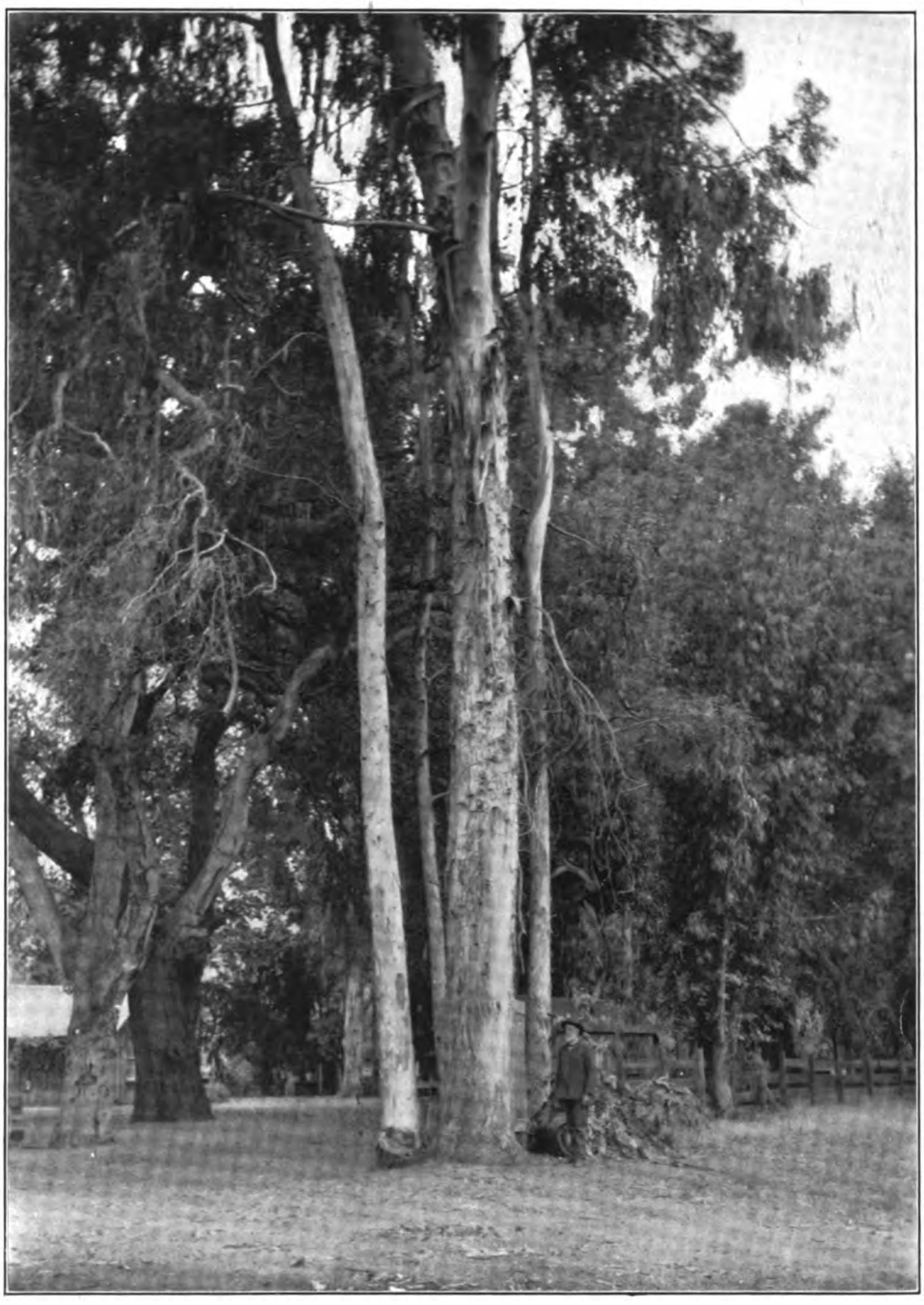
AS A SOURCE OF FUEL.

In Australia the Eucalypts are an important source of fuel. There the inhabitants find the tree, ready grown for use, and it matters little to them how long they have taken to reach their present size. Hence many species are used for this purpose. In America and other countries where the Eucalypts are grown as exotics the case is quite different. Only a quick-growing species will yield an early supply of fuel, and



EUCALYPTUS GLOBULUS, SANTA BARBARA, CAL.

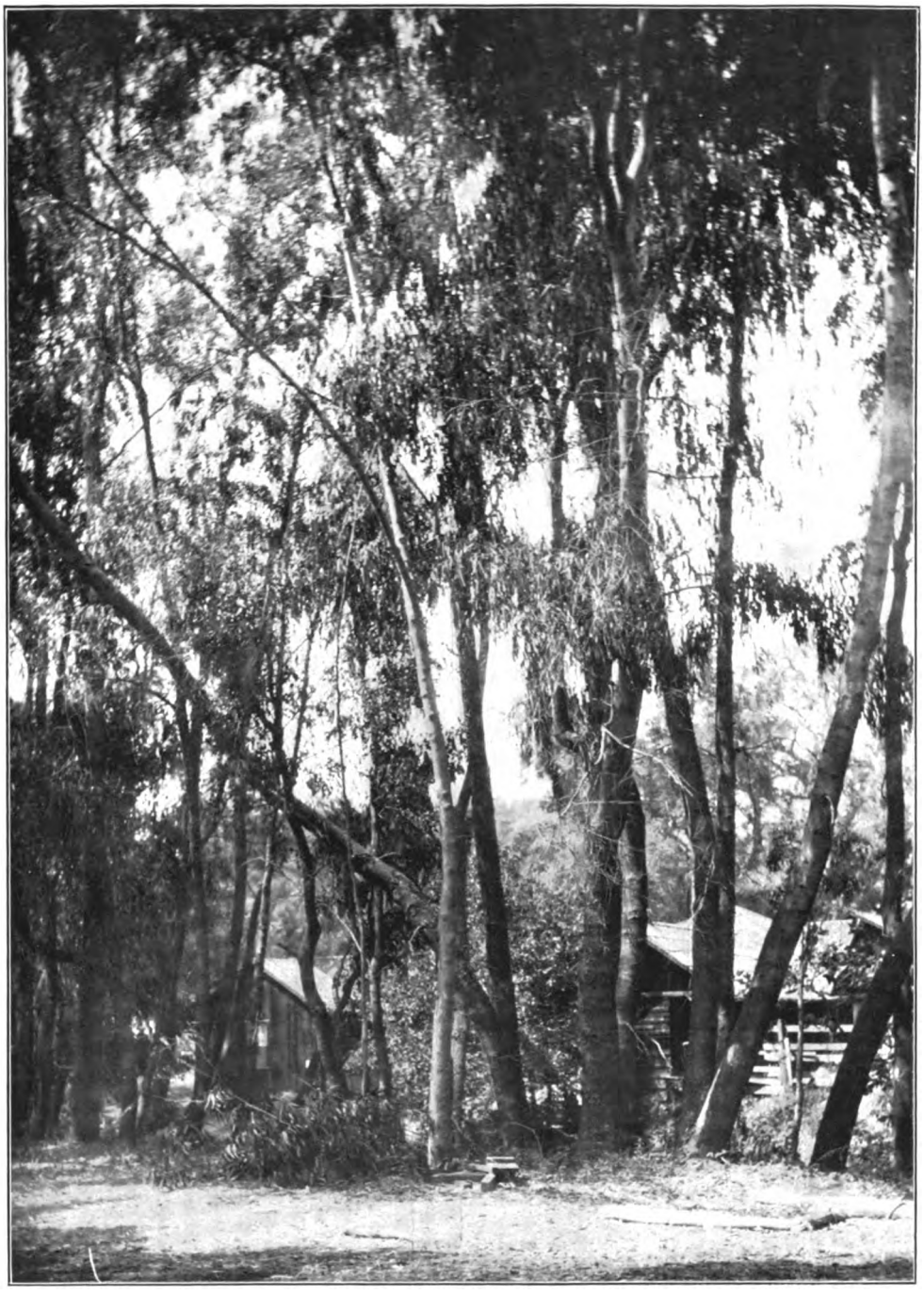
A row of trees 31 years old, ranging in diameter from 3 to over 5 feet. They were among the first planted in southern California.



EUCALYPTUS GLOBULUS ON RANCH OF ELLWOOD COOPER, SANTA BARBARA, CAL.

Trees 24 years old. The largest Eucalypt has attained in twenty-four years the diameter that the oaks have in over two hundred years.

EUCALYPTUS GLOBULUS. TIMBER CUT FROM TREES IN THE BACKGROUND BEING USED TO BUILD FENCE.



EUCALYPTUS GOMPHOCEPHALA. GROVE 24 YEARS OLD ON THE COOPER RANCH.

hence the Blue Gum among the Eucalypts has been most used for this purpose. (Pl. V, A.)

The Manna Gum (*Eucalyptus viminalis*), the species approaching the Blue Gum most closely in rapidity of growth, has also been cut considerably for fuel. Other species making a slower growth produce a harder wood and better fuel. For some years Mr. Cooper has been cutting stove wood for the Santa Barbara market from his Red Gum (*E. rostrata*) and Red Ironbark (*E. sideroxylon*) groves, and finds the fuel from them superior to that from the Blue Gum. (Pl. V, B.) When other species become more generally known, or when plantings now made have reached a sufficient age, undoubtedly several species will be found better adapted for fuel than the now much-used Blue Gum. But at present that is the fuel tree of much of the State of California. (Pl. VI, A.)

When set for fuel the young trees are commonly planted either 8 by 8 or 6 by 10 feet apart. Rows 10 feet apart with trees 6 feet apart in the rows give a few more trees to the acre, and leave more space between the rows for driving with a wagon. Formerly some growers planted closer—either 4 by 4 or 4 by 8 feet—and cut out the trees as they increased in size, until they were left the distance apart they desired them to be permanently. But so much difficulty was experienced in preventing the growth of the trees desired to be eliminated that the practice has been almost entirely abandoned. The young trees are commonly cultivated for about two years after being set out.

In California some of the best agricultural land is used for growing Blue Gum wood for market, usually in groves of from 10 to 40 acres. Not only are these groves profitable, but they add much to a landscape which without them was quite monotonous. Land unsuitable for tillage—hillsides, ravines, and rocky plains—is also much utilized. In such cases the return from the fuel produced is practically a clear gain. In July, 1900, the writer's attention was attracted to a grove of Eucalypts near Pasadena, Cal. Subsequently, in response to an inquiry as to the age of the grove, Mr. H. F. Shorting wrote as follows:

> The *Eucalyptus globulus* grove is 12 years old, and is in the worst sort of soil, for grapes, oranges, lemons, and barley have all failed. It is an old river bed. It was cut one year ago, and they are far better looking trees now than they were before being cut. (Pl. VII, A.)

There is undoubtedly much land in the Southwest now considered too poor for growing any crop that might profitably be set to fuel-producing groves of Eucalypts.

When 5 to 7 years old, groves of Blue Gum or Manna Gum may be cut to the ground for fuel, and they may be cut every six or eight years thereafter. The yield from each cutting is commonly 50 to 75 cords of 4-foot wood per acre. One 17-acre grove between Los

Angeles and Compton, set in 1880 and cut for the third time in June, 1900, produced 1,360 cords, an average of 80 cords of 4-foot wood per acre. (Pl. VI, B.) The price received by the owner for the crop was $2.50 per cord on the stump. It will be seen that this return fully justified the using of the heaviest of agricultural land for the growth of fuel. On poorer land the yield is only a third to a half the above amount. The size attained in good soil a short time after being cut is often remarkable. (Pl. VII.) In a grove near Pasadena, set in 1885 and cut for fuel in 1893, there were in July, 1900, some trees 2 feet in diameter and many over 100 feet in height.

Mr. Cooper estimates that at the rate his trees are growing he can cut from his 200 acres of miscellaneous species, set largely in soil too rough for tillage, 1,000 cords of wood per year indefinitely without in any way detracting from the appearance of the groves or from their usefulness in other ways. Judged by the known rate of growth of smaller groves, the above estimate is not high. The Eucalypt is evidently destined to be the future fuel tree of the Southwest. Even when settlement in this region began the hard-wood trees were limited in number, and these are rapidly disappearing under the woodman's ax. In much of the Southwest the oak has been a source of hard-wood fuel, but in many places the supply is about exhausted, and in none can it last indefinitely. Over a good deal of the region the Mesquite (*Prosopis juliflora*) has been the chief source of fuel, but even these trees are rapidly disappearing in the vicinity of the settlements. All available timber will soon be cut, and there is no known species except the Eucalyptus that can take its place and at the same time supply the increasing demand for hard-wood fuel. The extensive planting of Eucalypts in such localities would be a wise provision for the future.

Not only the wood of the Eucalypts is used for fuel, but in California the leaves are utilized for this purpose. A Los Angeles company is making for market bricks composed of Blue Gum leaves and twigs mixed with crude oil, and the product is reported to be an excellent fuel for domestic use. The entire tree is thus utilized. This new use of Eucalypt leaves suggests the possibility of many industries growing out of the extensive planting of the trees in the Southwest.

AS A SOURCE OF OIL.

While the stem and branches of the Eucalypts furnish timber and fuel, the leaves and twigs are the source of a very important oil. In Australia many species yield sufficient quantities to enable them to be utilized for oil production, but most of the oil produced there is obtained from three or four species. For many years the production of eucalyptus oil has been an important industry in that country. One of the first investigators and producers of this oil was J. Bosisto,

of Melbourne. Baron von Mueller states in the Eucalyptographia that in 1880 Bosisto was producing 6 tons of oil per year. Since then the demand for the oil has increased very much, and a much larger quantity is produced in Australia annually. During the past ten years considerable eucalyptus oil has been produced from the Blue Gum plantations in Algeria, it having been found advantageous to obtain the oil from solid plantations of one species rather than from native forests where the species grow mixed. In California considerable oil has been extracted from the Blue Gum during the past five years. The principal producer is a physician in Los Angeles, who is attempting to establish a reputation for putting up a pure high-grade product. During the winter of 1900–1901 he extracted 9 tons of oil. He does not distill out any eucalyptol, as he considers the oil in the form he puts it out superior for most purposes. The residue from the distillation of the refined oil from the crude product is put up for a salve. From the oil he manufactures a soap and cough drops. Hon. Ellwood Cooper has a young Blue Gum plantation on his ranch near Santa Barbara, from which he intends to manufacture both eucalyptus oil and eucalyptol. He will cut the trunk and limbs into fuel, extract oil from the twigs and leaves, and thus utilize the entire tree.

The different species vary greatly as to the amount of oil they will yield, the range being from none to 500 ounces from 1,000 pounds of fresh leaves and twigs. According to J. Bosisto and other Australian authorities and S. M. Woodbridge, of Los Angeles, the Peppermint Tree (*Eucalyptus amygdalina*) yields the largest amount. But in America this tree is not grown extensively enough for it to be a source of much oil. For some years yet, and perhaps always, the chief source of eucalyptus oil here will be the Blue Gum. The yield of crude oil from the leaves and twigs of this species ranges from 1 to 1.6 per cent. Dr. Herron extracted, during the past season, 9 tons of oil from 700 tons of leaves and twigs from this species—a yield of 1.28 per cent. H. B. Silkwood, proprietor of the California Eucalyptus Works, Garden Grove, Cal., reports that he produced 1 ton of oil from 100 tons of material during the past year, the output being limited by the available supply of Blue Gum leaves. The Red Gum yields much less oil than the Blue Gum—only 10 to 30 per cent as much.

The oils from the different species of Eucalypts differ greatly. As extracted they are all compounds or mixtures. The chief ingredient of the oil from the Blue Gum is a colorless, transparent, camphoraceous liquid called eucalyptol or cineol; of the Peppermint Tree (*Eucalyptus amygdalina*), a less known liquid called phellandrene; of the Lemon-scented Eucalypt (*E. citriodora*), a fragrant, highly volatile liquid called citronellon, mixed with another fragrant liquid called geraniol. Several other ingredients enter into the composition of the oils from the various species. The best known of all the ingre-

dients is eucalyptol, which constitutes about 60 per cent of the oil from the Blue Gum.

The medicinal properties of the various component parts of eucalyptus oil differ widely. Hence the oils from different species have very different medicinal values. Unless eucalyptol, the chief ingredient of Blue Gum oil, has the same effect upon the human system as phellandrene, the prominent ingredient of the Peppermint Tree oil, the oils from these two trees must necessarily have different medicinal properties, and the oil from a forest of mixed species must have very uncertain medicinal properties. The Eucalyptus oil produced in America, where the groves from which leaves are obtained for oil are commonly of one species, and where, with rare exceptions, a single species (Blue Gum) is the source of all the oil extracted, will necessarily be a product whose properties are better known and more constant than that produced from mixed native forests. Hence the importation of eucalyptol or Eucalyptus oil from Australia or elsewhere is both unnecessary and a disadvantage to the consumer. As Hon. Abbot Kinney remarks in his "Eucalyptus":

> The increased use of the eucalyptus oils derived from the solid plantations of *E. globulus* in California and Algiers is thus seen to rest upon reasonable grounds and must give increased reliability to medicinal preparations from the Eucalyptus.

Eucalyptus oil is so useful, and popular information concerning it is so meager, that a few words concerning it will not be out of place here. This oil has been used for about forty years, but only during the past ten years has it been employed in medicine very extensively. Its use is now constantly increasing, as its properties and medicinal value become better known. All druggists questioned on the subject stated that the demand for Eucalyptus oil was rapidly increasing. Two wholesale druggists of Los Angeles both stated in letters to the writer, written in response to inquiries on this point, that their sales of the oil had increased very much during the past few years.

The fact that it is nonpoisonous and nonirritant makes it especially safe and valuable. As much as a fourth of an ounce has been taken internally without injury, and it may be freely applied to the most delicate tissue. Notwithstanding the fact that it is neither dangerously poisonous nor irritating to the human system, it is a very effective antiseptic and disinfectant, and has come to be used quite extensively for dressing wounds, ulcers, and other diseased tissues. It enters into the composition of several antiseptic preparations. The oil is also a well-known remedy for malarial and other fevers, and is used in treating diseases of the skin, and of the stomach, kidneys, and bladder, and is especially valuable for affections of the throat, bronchi, and lungs.

In using Eucalyptus oil it is important that a pure article be procured. Unfortunately there is considerable adulteration of this oil with cheaper, inert, or harmful ones. No doubt this remedy would

A. EUCALYPTUS GONIOCALYX. TREES 24 YEARS OLD.

B. EUCALYPTUS TERETICORNIS. TREES 22 YEARS OLD.

EUCALYPTS ON RANCH OF ELLWOOD COOPER, SANTA BARBARA, CAL.

EUCALYPTUS HEMIPHLOIA. TREE 4 YEARS OLD, EXPERIMENT STATION FARM, PHOENIX, ARIZ.

EUCALYPTUS HEMIPHLOIA. TREES 24 YEARS OLD, COOPER RANCH, SANTA BARBARA, CAL.

be a more popular one but for the fact that so much of the oil for sale on the market is of such an uncertain nature. The safest way is to purchase none in bulk, but buy it in bottles put up by a reliable person or firm. It costs more in this form, but is far safer to use as a remedy.

The leaves of the Blue Gum and of a few other species, on account of the oil they contain, are employed as household remedies in localities where the trees grow. Among the natives of Australia they are said to be in common use for dressing wounds and for other purposes. In California, teas and poultices are made from the Blue Gum leaves for treating colds, wounds, and ulcers. The leaves are also steamed for the treatment of colds, catarrh, croup, bronchitis, and other affections of the respiratory system. Some go so far as to use regularly tea made from the leaves of Blue Gum, and, as they assert, with beneficial results.

AS A SOURCE OF HONEY.

The Eucalypts generally bloom so freely and so early in their development that as a group they are an important source of nectar for bees. The fact that some species can be found in bloom any day of the year, often during droughts when other blossoms are scarce, in many cases in great profusion, makes them especially valuable as a constant source of bee food. Mr. Kinney, who has made extended observations on the blooming of the Eucalypts, writes in his "Eucalyptus:"

> Taking the sixty species and marked varieties of this genus in southern California, I have never seen a day that flowers could not be found on some of them. * * * When we consider the free production of nectar by the Eucalyptus at seasons when there is little or no other resource for bees, and also the claimed medicinal value of honey from Eucalyptus flowers for relieving irritation from the mucous membrane, and as a nerve sedative, the presumption is strongly in its favor. Bee men will doubtless find it to their interest to study the species, and plant in waste places such sorts as will furnish the best kinds of nectar during the most difficult season for the bees. * * * I believe that by some study of this subject species of Eucalyptus with plenty of nectar could be so selected as to give a constant crop of flowers or flowers at such times as these are absent in other plants.

Naudin, in his "Description and Use of Eucalyptus," says of their value as a source of honey:

> Another use of the Eucalyptus * * * is supplying the bees with abundant provisions for food by their flowers, from which they withdraw a perfumed honey, endowed perhaps with peculiar hygienic properties.

Whether or not the Eucalypts give a peculiar medicinal quality to the honey may be a question, but it is certain that they are a valuable pasture for the bees.

Since Mr. Kinney wrote the above, beekeepers have become more interested in the Eucalypts as a source of nectar. William Shutt, foreman of the Santa Monica Forestry Station, informs the writer that

he receives many inquiries concerning the merits of certain species for bee pasture. In a subsequent portion of this publication will be found a list of the species useful for this purpose. In planting trees for forest cover, wind-breaks, shade, timber, or fuel it would be well, wherever the bee industry is important, to select varieties recognized as flower producers. Several species valuable for the purposes mentioned above—notably the Sugar Gum (*Eucalyptus corynocalyx*), the Red Gum (*E. rostrata*), the Red Iron bark (*E. sideroxylon*), *E. hemiphloia*, and *E. polyanthema*—are profuse bloomers and are thronged with bees during the blooming season, which with some species is quite protracted.

AS IMPROVERS OF CLIMATE.

The Eucalypts have the reputation of benefiting the climate of those regions where they have been planted. Evidence upon this subject is so conflicting, however, that the truth is ascertained with difficulty. Whatever the fact may be, the belief is quite general, especially in southern Europe, that the effect of Eucalypts upon the climate is distinctly sanatory.

The plantation of Eucalypts at Tres Fontane, in the Roman Campagna, is the instance most generally cited by those who contend for the beneficial influence of these trees on the climate. In fact, the general planting of Eucalypts throughout southern Europe seems to have been given a decided impetus by reports of the results at Tres Fontane. On this point Charles Belmont Davis, American consul at Florence in 1894, writes in Consular Reports No. 168 as follows:

> It is this latter quality [the property of distributing a balsamic atmosphere] which has brought the Eucalyptus into such prominence in Italy, and has been the cause not only of the planting of thousands of trees by private individuals and public corporations, but of its receiving the indorsement of the Italian Government as well.

He adds:

> Whether the plant does absolutely contain such a healthful quality as many attribute to it has always been and still is a question in the minds of many who have given the subject intelligent thought and systematic experiment. That the planting of these trees has met in some districts with a degree of success in allaying the ravages of malaria there would seem to be little doubt.

In the consular report mentioned above Wilbur B. Hall, American consul at Nice, writes:

> The Eucalyptus seems destined to revolutionize silviculture in the countries mentioned [France, Algeria, Italy, Spain, Corsica, Portugal, and Cape Colony], not only on account of the many remarkable properties of the tree, its resin, its wood, and its rapid growth, but also its great power of absorbing enormous quantities of water from wet and swampy lands, drying them and rendering them fit for cultivation, as well as its tendency to thus eliminate malarial conditions from the lands whence it grows.

M. Carlotti, who has studied Eucalypts exhaustively on the island of

Corsica, in his "Rendering warm, unhealthy regions healthy by means of the Eucalyptus," cites a large number of instances of improved climate attributed to the planting of Eucalypts.

M. Lambert makes similar statements as to the effect of planting these trees in Algeria. M. Gimbert also cites examples of the improvement of climate in Algeria, as well as in Cape Colony and other parts of Africa, due to the planting of Eucalypts. It is asserted by many Californians that the planting of Eucalypts has diminished the amount of malaria in central California. Others in various parts of the world have made similar claims.

On the other hand, some who have investigated the subject maintain that the fact of the improvement of climate by Eucalypts is not established. Perhaps the ablest of those who have combated the popular belief in the sanatory effect of Eucalypts is Prof. Tomaso Crudeli, who has investigated the subject carefully in Italy. He insists that up to the date of his writing (1886), "not a single instance of hygienic improvement by the sole means of Eucalypti has been ascertained, but the possibility of so doing is not denied."

Wallace S. Jones, American consul at Rome in 1894, writes as follows in Consular Report No. 168:

> In Italy, although the newspapers had persuaded everyone that the farm of the Tres Fontane, near Rome, had become healthful by means of the Eucalypti, it proved a disagreeable surprise to learn of a sudden outbreak of malaria in 1882 that caused much sickness among the farm hands, while the rest of the Campagna remained perfectly healthy. * * * Dr. Montechiare, a practicing physician of Rome, who for years was physician to the penal colony at Tres Fontane, tells me that his experience justifies him in declaring that no beneficial result against malaria has been derived from the planting of the Eucalyptus.

Those who fail to recognize the beneficial effects of the planting of Eucalypts also call attention to the fact that malaria prevails in many parts of Australia where these trees are abundant. It seems to be admitted, however, that malaria is absent, or at least not prevalent, in those parts of Australia where the Blue Gum, the species that is believed to have produced the beneficial result about the Mediterranean, is native or thrives. Whether this coincidence, if such it be, is due to the natural climate or to the effects of these trees would be somewhat difficult to decide.

It is probable that considerable of the change in the sanitary condition of those places said to have been benefited by Eucalypts has been due to other causes, such as the making of drainage ditches, etc., and this will partially account for the conflicting opinions on the subject. When, however, the nature and habit of the trees are considered, it is entirely reasonable to believe that to a certain extent they beneficially affect the atmosphere in the region of their growth. The grounds for this belief are: First, their great capacity for absorbing moisture from the soil, and thus reducing the quantity of stagnant

water in the ground at their roots; second, their corresponding power of giving off fresh from their foliage the water thus taken up by their roots; third, the exhalation from their leaves and other parts of volatile oils, which affect the climate not only directly but by changing the oxygen of the atmosphere to ozone; fourth, the purification of germ-infested matter by the foliage dropped upon the ground or in pools of standing water. From the combined action of these four characteristics is seems reasonable to believe that the trees would be beneficial to many climates.

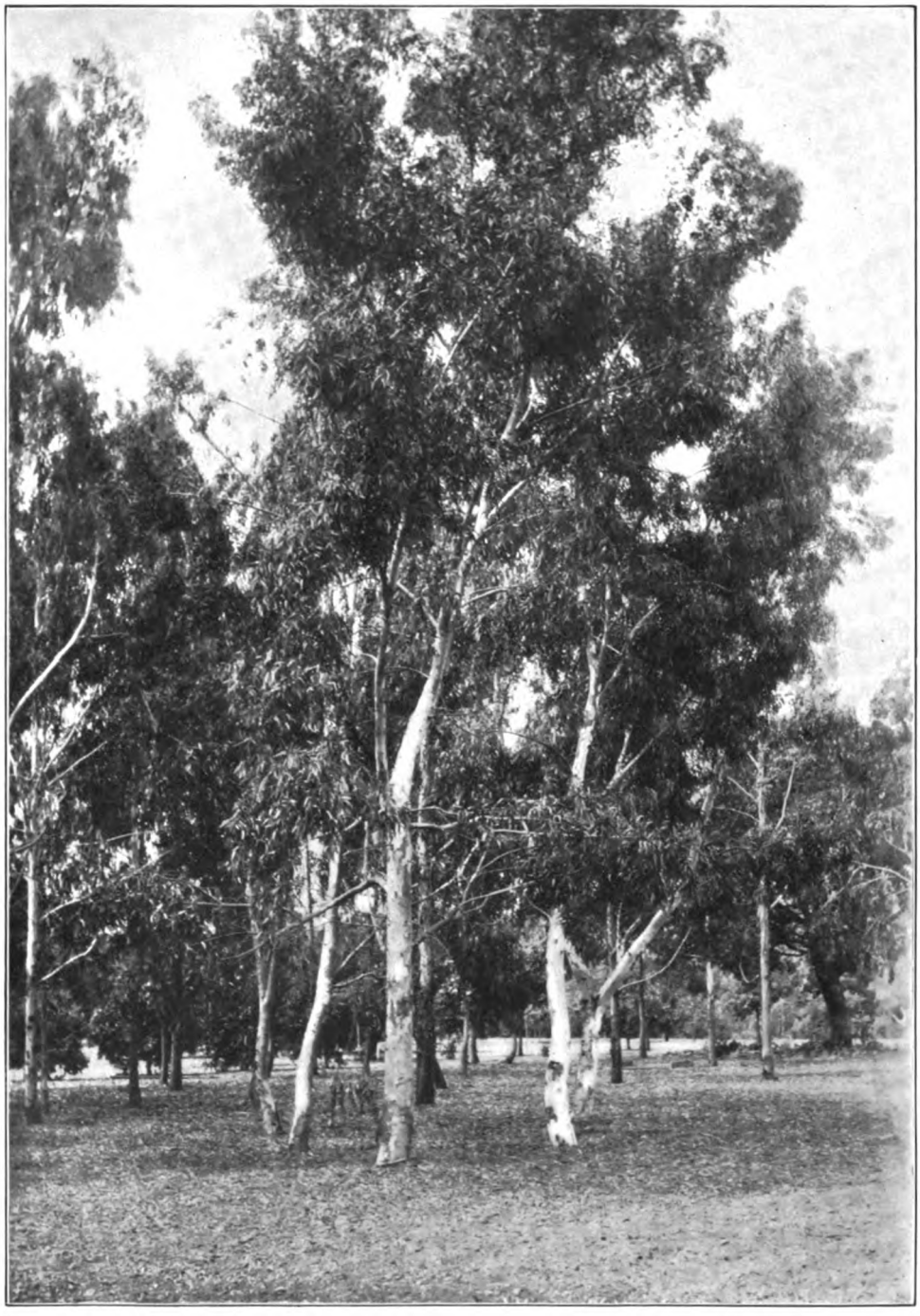
It is not necessary to determine, however, before setting Eucalypts, whether they have a pronounced beneficial effect upon climate or not. They certainly do not injure a climate. They serve so many other useful purposes that the question as to their effect upon climate may be waived, and the planting of them still go on from other motives. The belief that they improve climate has served a useful purpose regardless of the facts in the matter. The planting of trees is such a desirable thing that it matters little what the motive for planting them be, provided they get planted. Eucalypts may confidently be grown for a forest cover, for wind-breaks, for shade, for timber, for fuel, for the oil and the honey they furnish, and if, at the same time, they improve the sanitary condition of the region in which they are growing, the reward of the planter will be so much the greater.

PROPAGATION AND CARE OF EUCALYPTS.

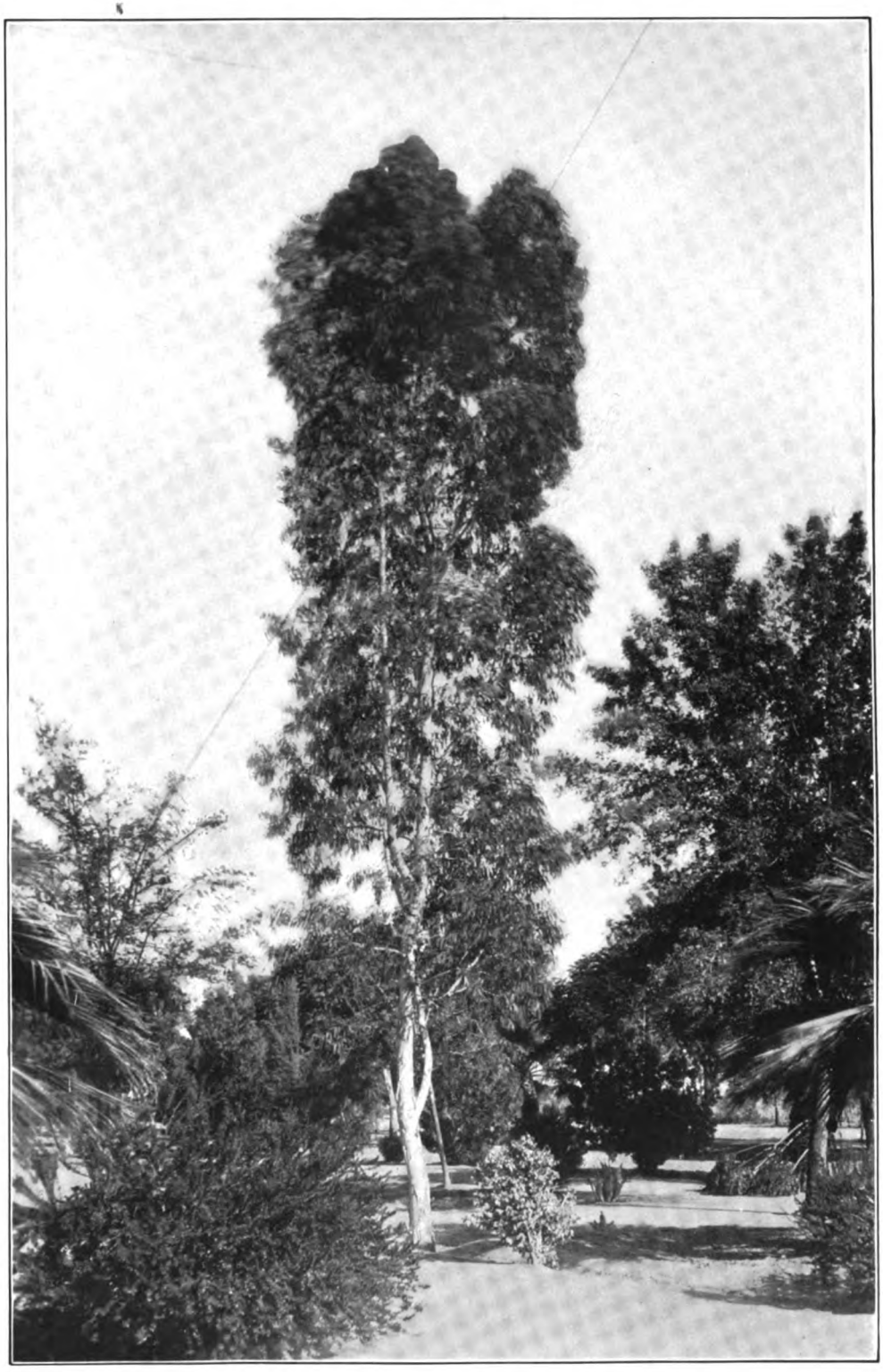
DIFFICULTIES IN GROWING SEEDLINGS.

Eucalypts are less easily propagated in America than most other forest trees. This is due in part to the smallness of their seeds and the infertility of many of them, and in part to the fact that each species requires, or at least prefers, certain peculiar climatic conditions. Few grow spontaneously in the Southwest yet, and none do so freely. The Red Gum and the Blue Gum are occasionally found growing spontaneously from fallen seed, and at Mr. Cooper's ranch near Santa Barbara Red Gum seedlings were seen by the writer in abundance under trees in shaded canyons, and in washes below the trees. (Pl. VIII.) Mr. Cooper also pointed out trees about a foot in diameter that had grown from volunteer seedlings. Southwest of Los Angeles, near the ocean, where the temperature is even and the atmosphere more humid than farther inland, young seedlings often appear in the groves of Blue Gums, and this occurs in similar situations in central California, being very noticeable on the university campus at Berkeley. On the Minnewawa ranch, near Fresno, seedlings of *Eucalyptus rudis* appear under the trees in abundance each spring, and are used by the owner for planting. (Pl. VIII, B.)

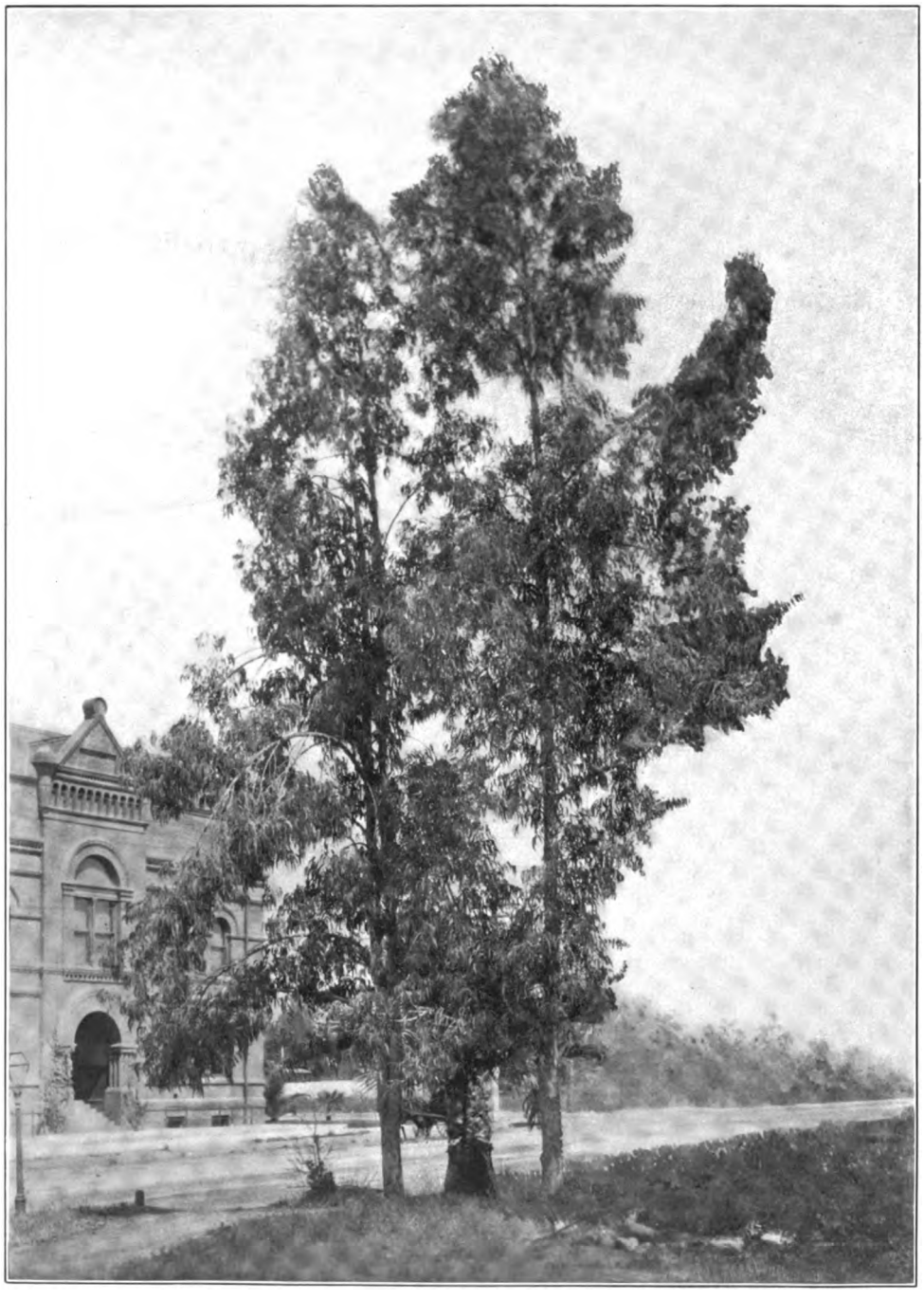
In some regions species which grow fairly thriftily when once started



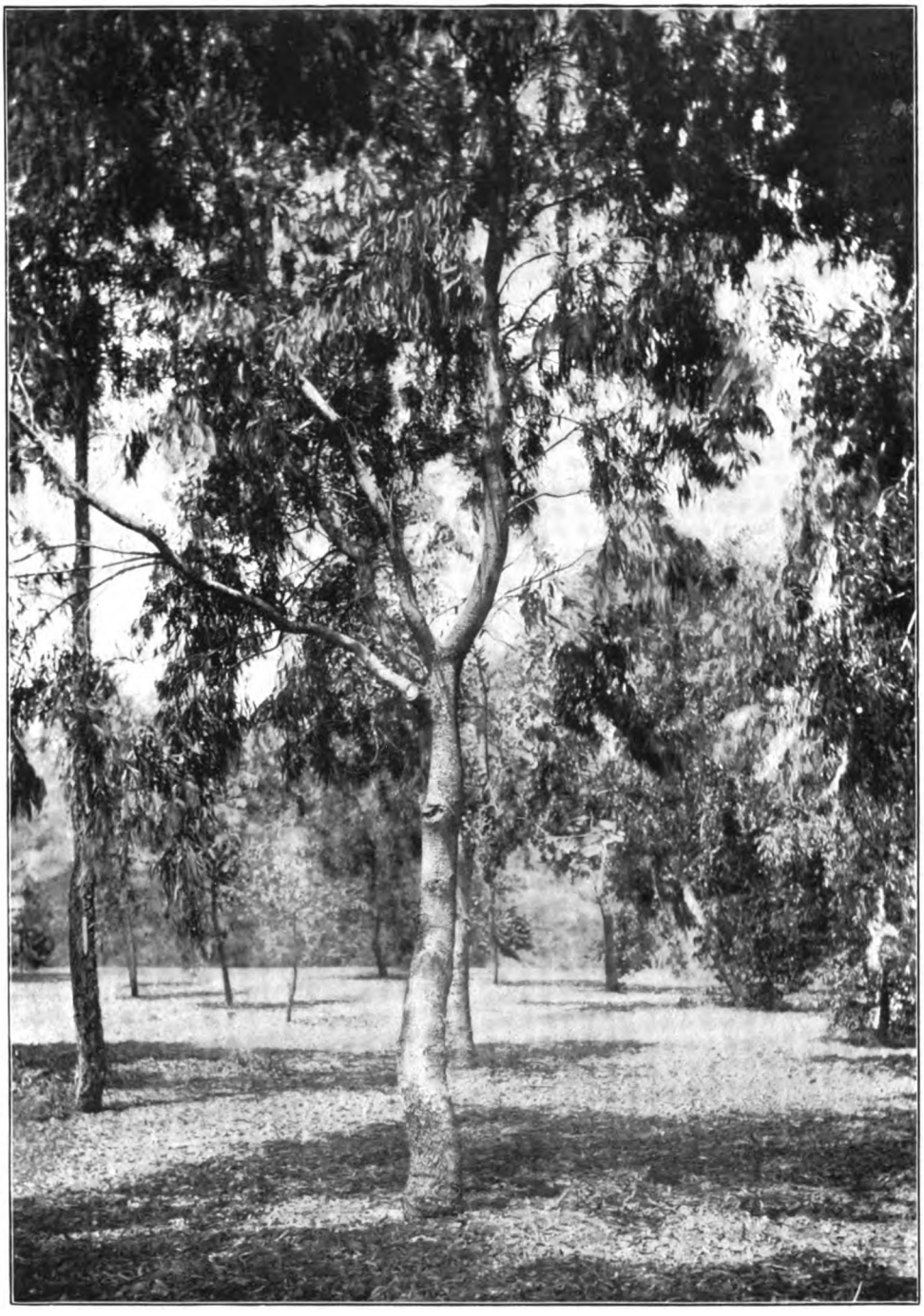
EUCALYPTUS LEUCOXYLON, STATE FORESTRY STATION, SANTA BARBARA, CAL.



EUCALYPTUS LEUCOXYLON. TREE 10 YEARS OLD, CAPITOL GROUNDS, PHOENIX, ARIZ.



EUCALYPTUS LONGIFOLIA, PASADENA, CAL.



EUCALYPTUS MELLIODORA, STATE FORESTRY STATION, SANTA MONICA, CAL.

are propagated from the seed with great difficulty. For example, the Red Gum (*Eucalyptus rostrata*), which grows quite well in southern Arizona from seedlings obtained from California, is propagated at Phoenix from seed with considerable difficulty. The case is similar to that of the orange tree, which, though thriving in the vicinity of Phoenix can not be easily grown there from seed. As a rule, however, Eucalypts that are well adapted to a region and thrive in it seem to be fairly easy to propagate there. The ease with which seedlings can be grown in any region may often, therefore, be taken as an indication of how well the adult trees will grow there.

Eucalypts are not commonly propagated in open soil, but in seed boxes, and ordinarily they need some protection from cold and from the sun during their early stages. Most species make a slow growth at first and are quite delicate, but when once fairly established they grow very rapidly.

PLANTING THE SEED.

The usual method of starting Eucalypts is to sow the seed in shallow boxes in especially prepared soil. A mixture of coarse sand and leaf-mold (two parts of mold to one of sand) is the best. This is placed in boxes a few inches deep; the seed is strewn quite thickly over the surface; a light covering of sand is placed on top, and this surface is then kept constantly moist. The young plants commonly appear in one or two weeks. After germination has taken place the soil should be kept moist but not wet. If kept too damp the young plants will be attacked by parasitic fungi and perish rapidly—"damp off," as gardeners term it. Applying the water about the middle of the forenoon, so that the soil and plants have time to become partially dry before night, is a precaution helpful in preventing damping off. In the experience of the writer there is nothing better for freshly sown seed, or for young plants, than a watering by a rainfall. Leaving the seed boxes out during a light rain will often start seed that artificial watering for weeks has failed to bring up, and young plants are very much refreshed and invigorated by a shower of rain.

Before transplanting it is well to harden the young plants by giving them only sufficient water to prevent wilting during the heat of the day. After a week or so, when they have become more woody, water should be applied freely for a few days, and they will then be in a better condition for transplanting than if this treatment is omitted.

TRANSFERRING TO FRESH SOIL.

When the young seedlings are 2 or 3 inches high, they should be transplanted into flats of fresh soil, putting in the plants about 2 inches apart each way. (Pl. IX, A.) This soil may contain less sand and more leaf mold than the seed bed. A mixture of leaf mold, sand, and

some soil similar to that in which they are to be set in the field is a good combination. If the plants are few and choice, it is usually best to transfer them from the seed bed to pots instead of to flats. From the pots they can be transplanted with less loss than from the boxes. They still need frequent watering, but the surface of the soil does not need to be kept as moist as during the earlier stages of growth. For a few days after being transferred they often need additional protection from drying. When they have become well established it is well to expose them to the sun and the outdoor air sufficiently to harden them before transplanting to the field.

The work of propagating Eucalyptus seedlings is not always accomplished successfully by those without experience in gardening or greenhouse work. Where the climatic conditions are at all trying, unless one has had some experience in propagating evergreen plants from small seeds, it will be better to purchase the trees of a grower. In the dry valleys of the interior it is especially difficult to grow young Eucalypts successfully. So many are lost from various causes, but largely because of the dryness of the atmosphere, that it will be found more economical to procure the plants from some grower located in a more favorable region.

But it is important that plants be purchased of a reliable grower. The species of Eucalypts are so numerous, the seeds so small, and the different species so similar in the earliest stages of growth, that it is easy for honest confusion to arise in the mind of a grower who is not conscientiously careful. When to this is added unscrupulousness, the danger of not getting the species desired or called for is quite great. The Blue Gum seedlings are so well known that growers or buyers are seldom deceived in them. But it is not safe to buy any other species of any but a thoroughly reliable grower. Many nurserymen, if they have not the species called for, or are so ignorant as to be unacquainted with it, will substitute some entirely different species, thinking the purchaser will not know the difference, at least for some years. Last spring (1901) a Los Angeles nurseryman sold a farmer plants of *Eucalyptus robusta* for both Sugar Gum (*E. corynocalyx*) and Red Gum (*E. rostrata*), the former in cans and the latter in flats.

SETTING IN THE FIELD.

When the seedlings are from 4 to 8 inches high they are right for setting in the field. (Pl. IX, B.) They usually attain this size when they are from 4 to 6 months old, but species vary considerably as to the time required to bring them to the given size. They bear transplanting better, and make a better start after being set out, at this age, than they do when older and larger. In some parts of the South and Southwest they can be set out in the field almost any time during the year. In other localities it is difficult to get them started in the

field except during certain seasons. In California they are commonly set out from February to May, but may be set considerably earlier or later in many parts of the State. Where heavy frosts occur during the winter it is best to wait until the danger of their occurrence is over, as many Eucalypts that endure frost when older are quite sensitive when young. In southern Arizona the best months for setting are March and April, just after the winter rains, and July and August, during the summer rains. They can be started most successfully there during the latter part of March.

If the Eucalypts are being set primarily for shade they may be set in single or double rows, 10 to 20 feet apart in the rows, along fences or irrigating ditches, or on each side of a road; or they may be scattered about the barnyard or the stockyard. But if they are being set for timber or for fuel it is best to set them 8 to 16 feet apart each way in solid blocks. When set in this manner they grow straighter (thus making more serviceable timber), split more readily for fuel, and are in every way more useful than if they grow scattered about and exposed to distorting winds. Some species, like the Red Gum, that are slender and easily distorted by the wind the first year or two, will grow straighter if corn be planted among them. In regions where the sun is trying the corn serves as a partial shade, as well as a wind-break. But as stated before, Eucalypts thrive best in bright sunlight, and it is not well to permit the corn to encroach too closely upon the young plants.

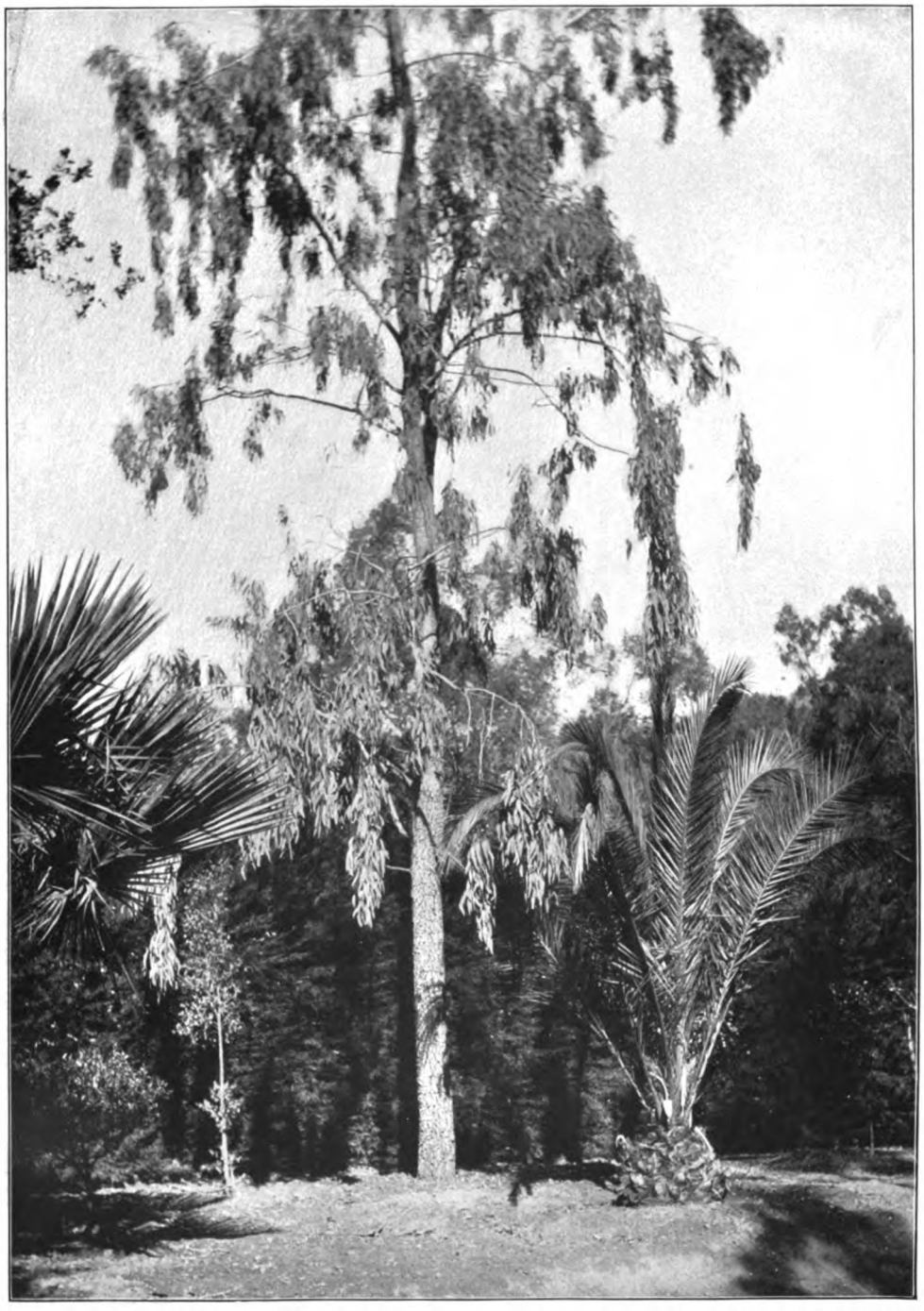
SUBSEQUENT CARE.

The young plants should be given some water when set out, and in many cases the watering will need to be continued for some time. How long after setting the application of water should continue will depend upon the climate, and upon the weather that follows. In the coast region of California, where night and morning fogs are frequent, little artificial watering is necessary. Farther inland trees need to be watered for several weeks at least. In the dry valleys of southern Arizona, New Mexico, and Texas they should be irrigated at least throughout the first season, and will make more satisfactory growth if irrigation be continued several years. After their root system is well established a few irrigations during winter when water is abundant will be all they they will need in most of this region. If set along irrigating ditches or canals it will be necessary to water them by hand only a few months, until the roots have pushed down into the permanently moist soil.

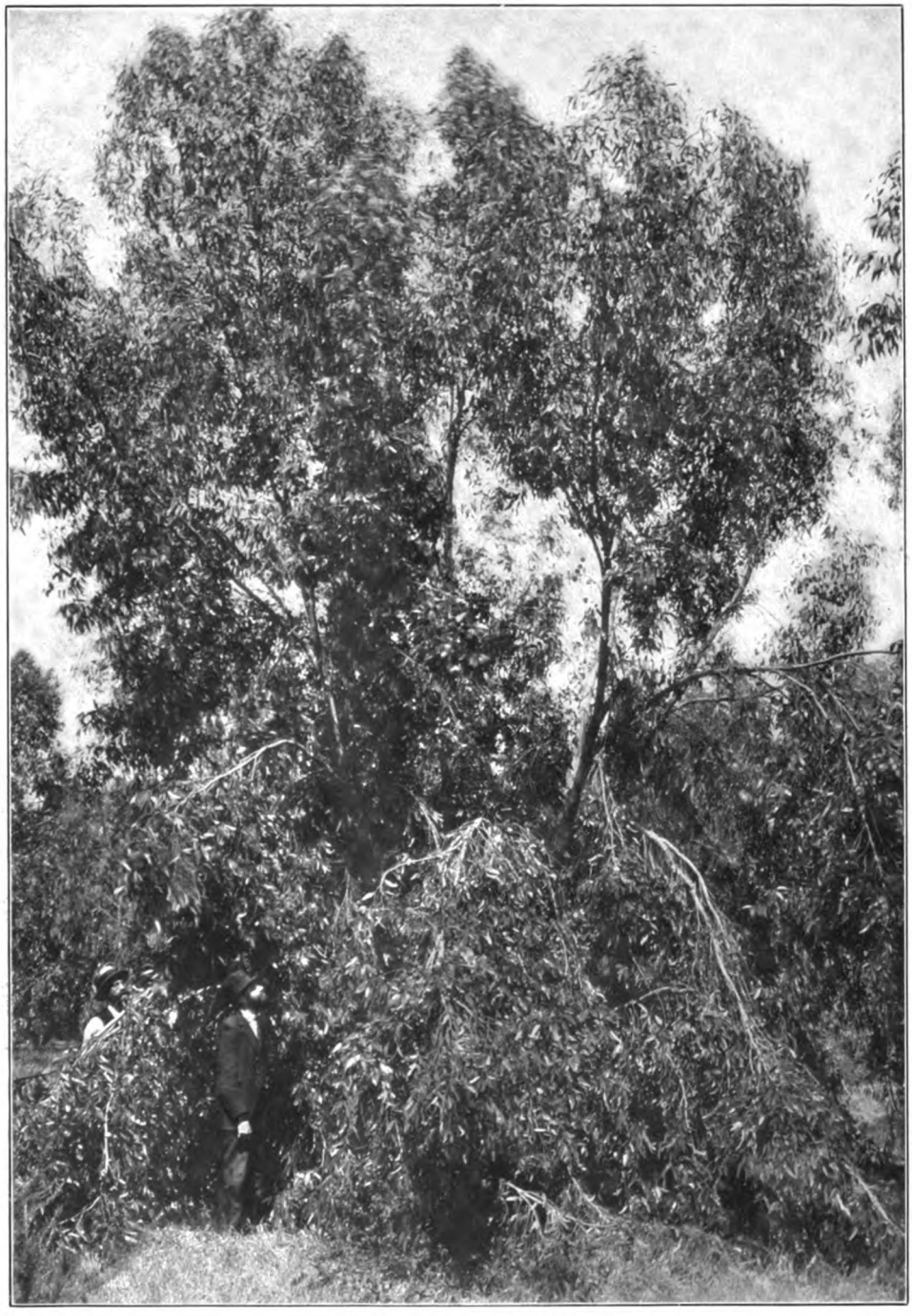
As most of the Eucalypts are quite delicate plants when small, they will need careful attention the first season. They should be cultivated and kept entirely free from weeds for from one to three years, according to the species and the condition of the soil. In many cases they

will need some protection from animals. Rabbits and other rodents sometimes nibble off young plants. If these animals can not be destroyed or excluded from the field, it will be necessary to protect each seedling from their ravages by means of a sheath of woven wire or other suitable material.

The great usefulness of the trees and the considerable length of time they are likely to remain where planted warrant the planter in giving the young plants all the attention they need until they become established. The Blue Gum is one of the easiest of the genus to start and needs less attention than most species, but it should be cultivated and protected from rodents for at least the first season. Any species should be given at least as much care as would be given a field of corn. The cost per acre for the care of the young seedlings need not be much greater than the cost of caring for a corn crop. To set young trees and then leave them to struggle with weeds, to suffer for want of water, or be injured by animals is not economical. Eucalypts, like most trees, will endure quite unfavorable conditions when once established, but they need careful attention until they become thus fitted to cope with such conditions.

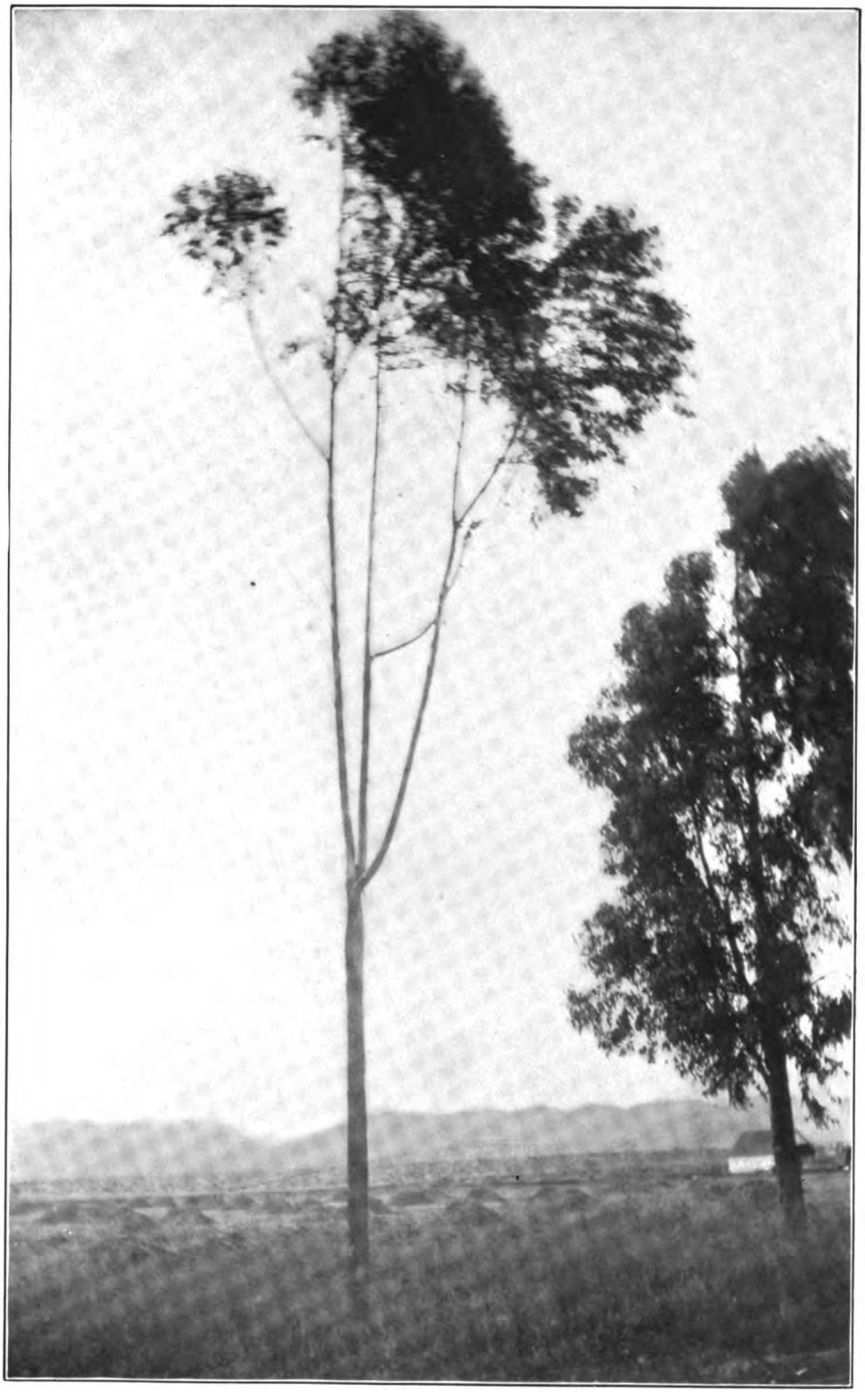


EUCALYPTUS MICROTHECA, MONTECITO, CAL.



EUCALYPTUS OCCIDENTALIS, NEAR SANTA MONICA, CAL.

EUCALYPTUS PANICULATA, STATE FORESTRY STATION, SANTA MONICA, CAL.



EUCALYPTUS PILULARIS, NEAR SANTA MONICA, CAL.

PART III.

PRINCIPAL SPECIES OF EUCALYPTS GROWN IN AMERICA.

In discussing the following species of Eucalypts the aim has been to use as few technical terms as possible. However, the species of the genus Eucalyptus are so numerous (about 150), and have been known to the civilized world for such a comparatively short time, that satisfactory popular names have not yet been assigned to many of them. Hence, it has been necessary to head the discussion of each species with the scientific name, adding whenever practicable a common name.

To be sure, the majority of species discussed here are known to have names applied to them by the aborigines of Australia, and the English colonists have assigned names to most of them. But the different native tribes, and the colonists as well, have different names for the same species. For example, *Eucalyptus microtheca* has seven known native names and six colonial ones; and *E. viminalis* and *E. amygdalina* are each known by nine different colonial names. To add to the confusion, the same English name is applied to many different species. As illustrations of this, the term "Blue Gum" is applied to twelve species; the term "Flooded Gum" is applied to seven species; the term "Ironbark" to eight species; the name "Red Gum" to nine species; the name "Stringy-bark" to eleven species, and the name "White Gum" to thirteen species. As Abbot Kinney observes in his work "Eucalyptus," each district in Australia has a nomenclature of its own for the Eucalypts, and thus the common names are, with few exceptions, confused and uncertain.

As there are already over fifty different species of Eucalypts grown in America it will undoubtedly be a good many years before many of them will be known popularly by well-established common names. In the meantime it will be necessary to continue using the scientific names in order to designate them accurately. *Eucalyptus globulus*, on account of its predominance in the Southwest, has come to be well known as the Blue Gum, but at least one of the eleven other species known by this name in Australia, which is also a promising species for parts of America (namely, *E. leucoxylon*), is entitled on account of its general aspect to be known here by this same name. If by common consent the latter could come to be known as the "White Gum," in reference to the white bark and wood of the tree (the specific name, leucoxylon, meaning in

Greek "white wood,)" as it is known in parts of Australia, the prospective difficulty would be obviated. A name concerning which there is considerable confusion is "Red Gum." Probably the species most entitled to it is *E. rostrata*, but both in Australia and America the name "Red Gum" is applied to several additional species for which there is no other good popular name. In America the name "Sugar Gum" has been applied to *E. corynocalyx* alone, so far as known; and the term "Manna Gum," so far as it has been used at all, to *E. viminalis* alone. *E. cornuta*, and this species alone, is known here to some extent as the "Yate," and the name "Bloodwood" seems to be applied to *E. corymbosa* only. But few, if any, others of the fifty or more species growing in America are yet known widely by any common names.

Consequently, the reader of this publication, and growers of the species for some years to come, will have to bear patiently with the use of the botanical names of the species. There will be no great hardship or inconvenience in doing this, as most of the names are quite expressive, referring to some prominent feature of the trees. For example, *calophylla* means "beautiful leaved;" *coriacea* means "leathery," referring to the leaves; *corynocalyx* means "club-shaped calyx;" *cornuta* means "horned;" *diversicolor* refers to the diverse colors of the two sides of the leaf; *globulus* refers to the globular seed-cases; *goniocalyx* means "angled calyx;" *hæmastoma* means "bloody or red mouthed;" *leucoxylon*, "white wood;" *longifolia*, "long leaved;" *citriodora*, "citrus odored" (referring in this case to the citrus fruit, lemon); *melliodora*, "honey odored;" *microtheca*, "small seed-case;" *obliqua* refers to the oblique leaves of the tree; *polyanthema*, "many flowered;" *punctata*, "dotted;" *resinifera*, "resin-bearing;" *robusta* refers to the robust appearance of the tree; *rostrata* refers to the rostrate or beaked flower buds; *saligna* means "willow wood;" *sideroplhoia* means "iron bark;" *sideroxylon*, "iron wood;" *tereticornis* means "round-horned," referring to the terete or cylindrical flower buds, and *viminalis* means "osier willow." The termination "oides" means "like," the specific name *acmenoides*, for example, meaning "acmen-like;" *botryoides* meaning botrys or grape like, (referring to the clusters of the seed-cases), and *eugenioides* meaning "Eugenia-like," referring to Eugenia, a plant genus of Australia. A few specific names (and fortunately only a few of those applied to Eucalypts generally planted) are Latinized forms of proper names, having been assigned by the namer and describer in honor of some botanical worker. For example, *Eucalyptus gunnii* is the Latin for "Gunn's Eucalypt;" and the name *stuartiana* was assigned in honor of a collector named Stuart. *Eucalyptus*, the name of the genus, means, as has been stated, "well concealed," referring to the complete manner in which the essential organs of the flower are covered.

The paragraphs giving the characteristics of the several species discussed were all written or revised under typical trees of the respective species. It is hoped that they are sufficiently accurate and explicit to enable a planter, aided by the illustrations, to decide more or less definitely whether a particular tree in question is what it has been represented to be, or is supposed to be. If there is no clue to the name of a tree, the name of which is desired, it will be necessary to resort to the use of the keys and descriptions given in the botanical section of this bulletin. For this work a good hand lens and some knowledge of botanical terms are essential.

The climatic requirements of the Eucalypts described here have been determined mainly by personal observation and experiment in the Southwest. In some cases, where the species has been cultivated only to a limited extent in America, inferences in regard to the climatic requirements of the tree have been drawn from its native habitat. This is not entirely safe; but an attempt has been made to make statements based on such data very guardedly, as it can not always be prophesied from a knowledge of the native environment of any particular species just how it will behave in a foreign country. The maximum temperatures given as the degree of heat a species will endure are those recorded in the shade 5 feet from the ground by a self-recording thermometer.

The information given concerning the uses of the several species is drawn largely from Baron von Mueller's "Eucalyptographia" and "Select Extra-tropical Plants," Mr. Maiden's "Useful Australian Plants" and "Commercial Timbers of New South Wales," and Mr. Bailey's "Queensland Woods," since most of the species have not been grown in America long enough nor planted extensively enough to furnish independent data concerning many of the uses of a large number of the species. A notable exception to this is the Blue Gum (*Eucalyptus globulus*), which has already been used for a great variety of purposes, including wind-breaks, forest cover, shade, fencing, piling, fuel, and oil. A few others have been used for fuel and for timbers. The only useful purposes that many of them have yet served in America are as shade trees, wind-breaks, and bee pasture.

Eucalyptus amygdalina.

GIANT EUCALYPT; PEPPERMINT TREE.

Characteristics.—In its native country the individuals of this species are the tallest of the genus, and probably the tallest trees in the world. In his "Eucalyptographia," Baron von Mueller says of this species:

This Eucalyptus is one of the most remarkable and important of all the plants in

the whole creation! Viewed in its marvelous height when standing forth in its fullest development on the slopes, or within glens of mountain forests, it represents probably the tallest of all trees of the globe; considered as a hard-wood tree of celerity in growth, it ranks among the very foremost; * * * and contemplated in respect to the yield of volatile oil from its copious foliage, it is unsurpassed and perhaps not equaled by any other tree in the whole world.

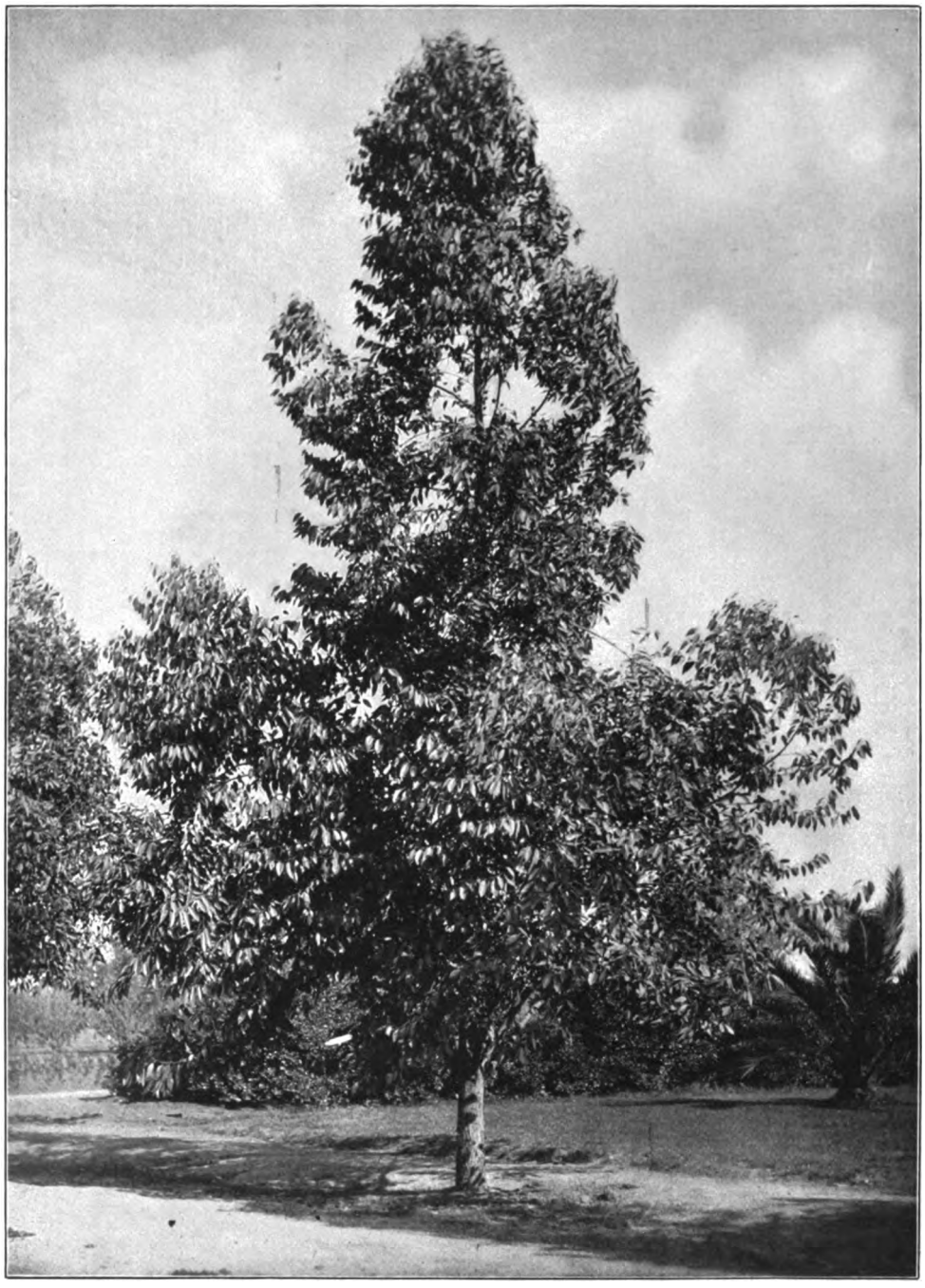
He speaks of recorded heights of over 400 feet and of diameters of 18 to 35 feet. One tree furnished a log 220 feet long, 12 feet in diameter at the top, and 30 feet in diameter at the base—an immense stick of hard-wood timber! While claiming that this Eucalypt is the tallest tree in the world, Baron von Mueller admits that in respect to height combined with diameter "it must cede the palm of superiority perhaps" to the Sequoias of California. In most other countries outside of Australia, this Eucalypt has not attained extraordinary heights; nor does its rate of growth prophesy great size. (Pl. X.) In the Southwest many other species grow more rapidly and have attained greater height since their introduction.

The tree is a very variable one, the size and habit depending upon the soil and the climatic environment. The great heights mentioned are attained in cool, moist ravines. Baron von Mueller says that in more open country it is of much lower stature, in some cases being comparatively a dwarf. It is the latter form that is known as "Peppermint Tree." In the Southwest it is exceedingly variable, running into forms that are evidently worthy of varietal names. The bark is also quite variable, being either rough and persistent or flaking off and leaving a smooth, yellowish surface. The trunk is fairly erect, but the small branches usually droop willow-fashion. The leaves are of medium size, varying from very narrow to lance-shaped. They are usually more or less curved. The narrow leaves are quite thick, the wider ones thinner. They are equally green on the two sides, and commonly have a distinct odor of peppermint when crushed. The flowers are small, in compact clusters of 8 to 15. The seed cases are small and nearly top-shaped. (See Pl. L.)

Climatic requirements.—The tree endures low temperatures, but is injured by dry heat. It does best near the coast and at moderate elevations in well-watered mountain regions. In no part of the Southwest do the requirements seem fully met.

Uses.—The timber is not so valuable as that of many other Eucalypts, but is said to be useful for shingles, rails, and for planking in ships. It is comparatively light, unlike many other Eucalypts, floating on water. It does not usually last well underground, nor does it furnish fuel of good quality. The leaves are a source of Eucalyptus oil. Baron von Mueller states that the fallen leaves of this and some other species deodorize the soil. He recommends the planting of it in swampy fever regions, where climatic conditions are suitable.

EUCALYPTUS POLYANTHEMA, ON GROUNDS OF GEORGE C. ROEDING, FRESNO, CAL.



EUCALYPTUS ROBUSTA, NEAR SOUTH PASADENA, CAL.

a basal diameter of 20 feet have been seen. The trunks are usually straight and even, and the grayish bark usually smooth. The latter is commonly persistent, but occasionally irregular pieces flake off. (Pl. XIX.)

The foliage is attractive in appearance, the leaves of the young seedlings being oval or roundish (See Pl. LXXXIII, B), and those of the adult tree narrower. They are dark green above and paler beneath, the latter characteristic, although possessed in common with several other Eucalypts, giving cause for its specific name *diversicolor*. The flowers grow in clusters of 4 to 8, with rather slender, somewhat flattened stalks. The seed cases are egg-shaped or goblet-shaped. (See Pl. LVIII.)

Climatic requirements.—This species thrives in moderately moist situations near the coast, but does not endure well the dry heat of the interior. It is said to be quite resistant to frost. The best specimens observed by the writer grow between Los Angeles and Pasadena, Cal., where the atmosphere is moderately humid and the frosts light.

Uses.—In situations favorable for its culture the Karri may be grown for a forest cover as a rival to the Blue Gum. Its growth is fairly rapid, and its timber is superior to that of Blue Gum for some purposes. The wood is straight-grained and is used in Australia for lumber (for which it is especially valuable), for wheelwright work, and for shipbuilding. The tall, straight trunks make good masts.

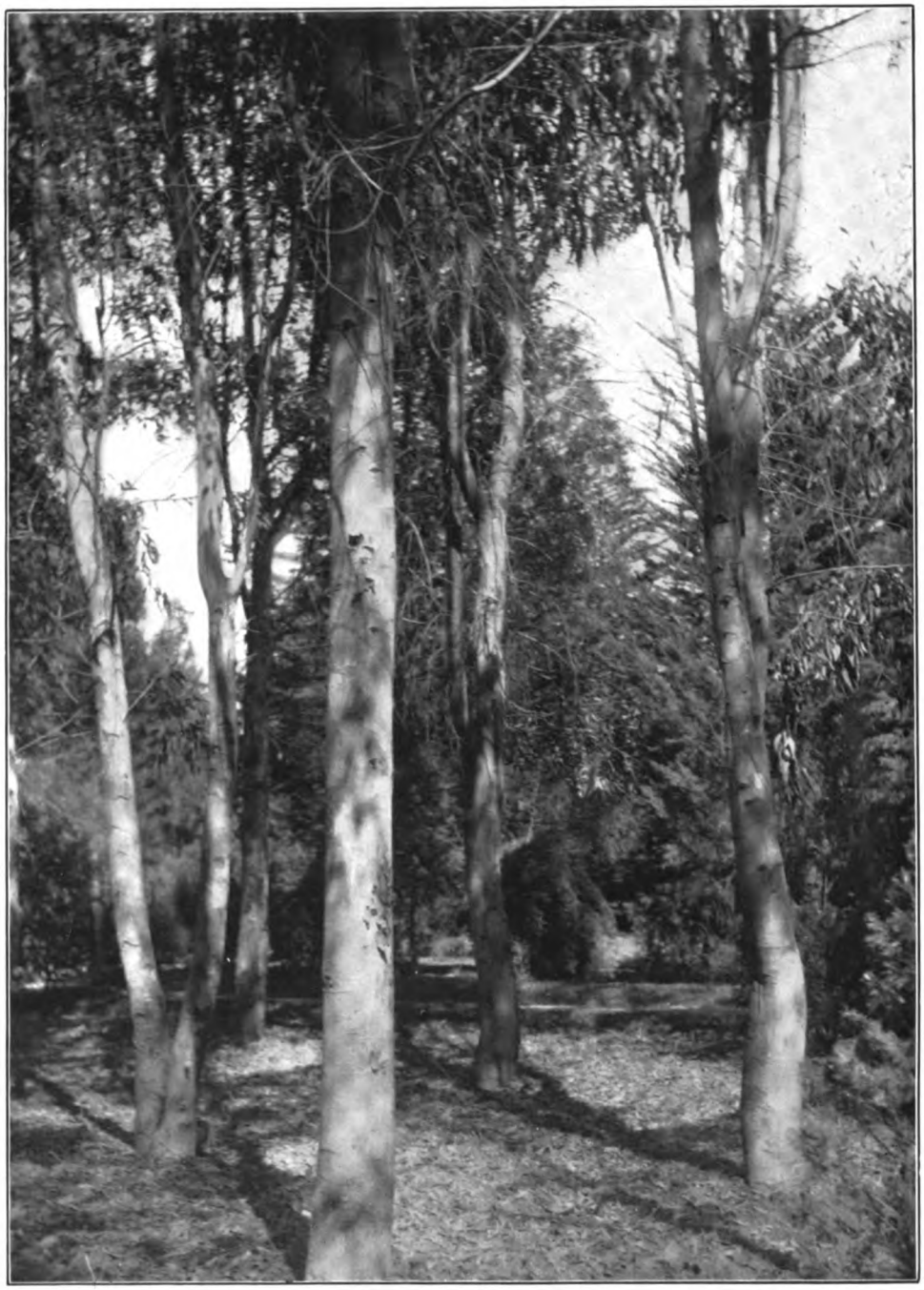
Eucalyptus eugenioides.

WHITE STRINGY-BARK.

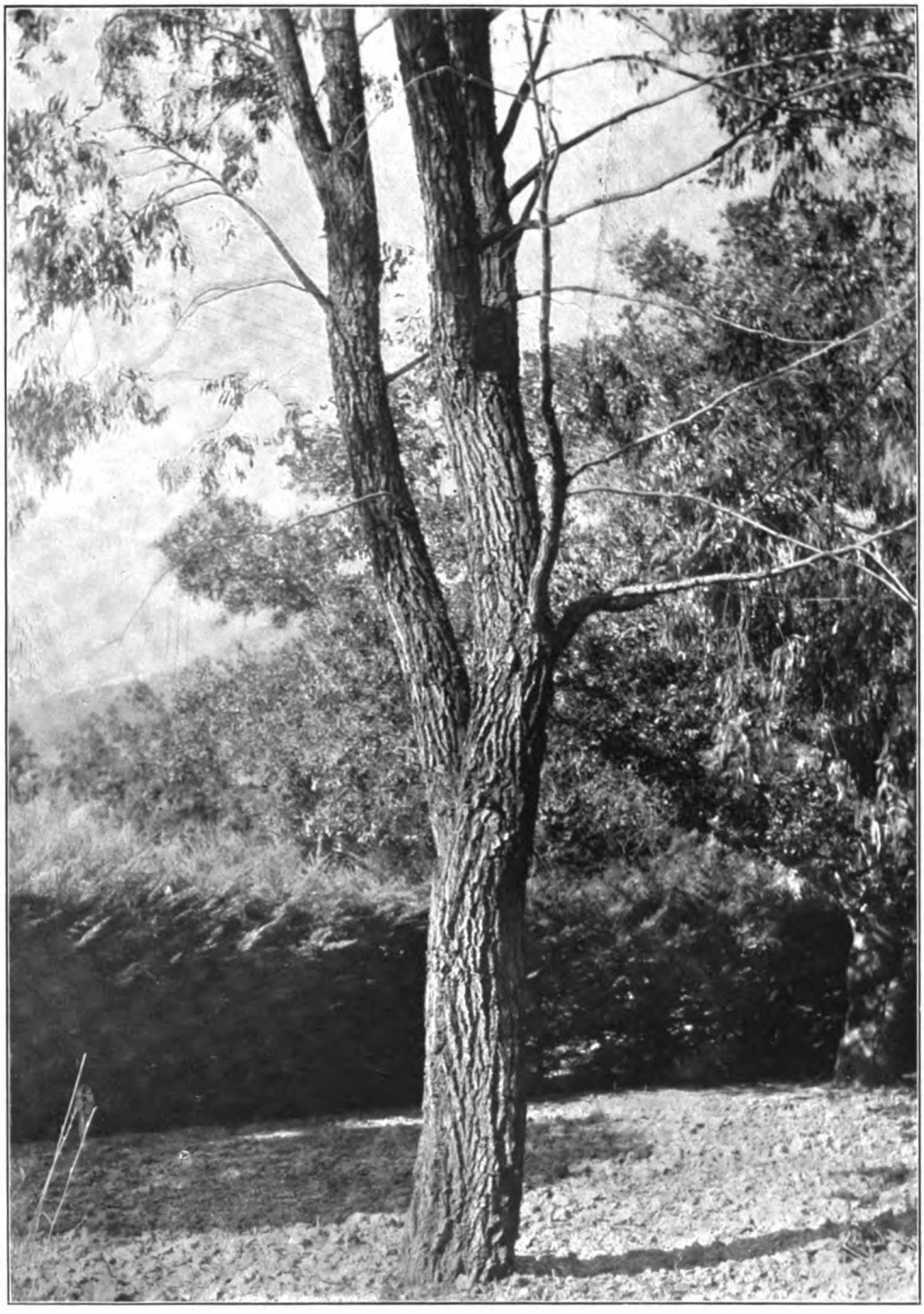
Characteristics.—Under favorable conditions this tree attains a good size, reaching in Australia a height of 150 to 200 feet even in sandy soil. It is a shapely tree when young, presenting a pleasing appearance. The bark is rough and persistent, the outer surface being soft and stringy. The fibers of the bark possess, in common with those of other "Stringy-barks," considerable tenacity. The bark as a whole resembles considerably that of American cedars, the color being a mixture of dark gray and tan. (Pl. XX.)

The young seedlings are clothed with soft hairs, and the leaves are opposite and notched. Later the twigs become smooth and the leaves regular in outline, the latter being ovate or lance-shaped, often with unequal sides, with the two surfaces of the leaves nearly equally green. The foliage is quite dense. The flowers are of medium size, in compact clusters. The seed vessels are cup-shaped. (See Pl. LIX.)

Climatic requirements.—This Stringy-bark is best adapted to a moderately humid region with a climate not too hot. It does fairly well near the coast of California, but does not endure the dry heat of the interior valleys.



EUCALYPTUS ROSTRATA. TREES 8 YEARS OLD, EAST LAKE PARK, LOS ANGELES, CAL.



EUCALYPTUS SIDEROXYLON, MONTECITO, CAL.

EUCALYPTUS VIMINALIS, PASADENA, CAL.

Tree 24 years old. Diameter of trunk, over 5 feet.

EUCALYPTUS VIMINALIS, SOUTH PASADENA, CAL. TREES 12 YEARS OLD.

Uses.—The timber is strong and durable, splits readily, and is not liable to warp. It is useful for lumber, for fence rails, and for posts. The bark is used for roofing, for mats, and for strings. The leaves are a source of Eucalyptus oil.

Eucalyptus globulus.

BLUE GUM.

Characteristics.—This species is the best known of the Eucalypts and in many respects the best known tree in all the world. Baron von Mueller says of it: "Of the more than 1,000 different species of trees indigenous to Australia, *Eucalyptus globulus* takes the first position in importance, and among its own kind it is the prince of Eucalypts." It is the third tallest of the species of Eucalyptus, the usual height in Australia being 200 to 300 feet. In California, where trees can be found 30 or more years old, many have attained the height of 150 feet, and a diameter of 3 to 6 feet during these years. One tree in Pasadena, 25 years old, is over 5 feet in diameter. Trees set thirty years ago along an avenue in Santa Barbara range from 3 to 5 feet in diameter. (Pl. XXI.) There are many instances of these trees attaining the height of 50 or 75 feet in from five to ten years. It is without doubt the fastest growing tree in the world. It is friendly to new conditions, and, taking all its characteristics into consideration, it is the best all-round Eucalypt. It has been more extensively planted throughout the world than any other Eucalypt and probably more extensively than all other Eucalypts combined. The tree varies as to its habit of growth, but is usually quite erect, though not always symmetrical in form. By a continual flaking off of its bark in patches or long strips it is left smooth and greenish or grayish in color. Occasionally, however, trees are seen with the bark persistent, especially near or at the base. (Pl. IV, A.)

The leaves of the young seedling and of sprouts from the tree are quite different from those of the adult trees. The earlier leaves have a dusty, light-bluish coat, and are broad and opposite on the stems (see Pl. LXXXIII, C), while those of the adult are smooth and elongated. The young twigs are four-sided, while those on the adult trees are cylindrical, or nearly so. The flowers are large and quite conspicuous. They grow singly or in clusters of 1 to 3. A prominent characteristic of the flower bud is its rough, warty protuberances. The seed cases are large and nearly hemispherical in form. (See Pl. LX.) The seeds are larger than those of most of the species.

Climatic requirements.—This remarkable tree has the power of adapting itself to a variety of climatic conditions. It thrives both in moist, warm regions and in quite hot, dry ones. It makes a good growth both in lowlands and in dry, stony uplands. Its powers of removing stagnant water from low situations and of maintaining a

thriftiness in dry situations and during droughts are remarkable. In many situations in the Southwest, where, during the three years 1897 to 1900, the annual rainfall was from 4 to 8 inches only, the Blue Gum, in most cases, maintained a thrifty growth.

These trees are resistant to both quite high and quite low temperatures. While the young trees will not usually endure a continued temperature much below 27° F., they will endure maximum temperatures of 100° to 105° F., if the air is not especially arid; they do not, however, endure maximum temperatures much above 105° F. in the dry interior valleys of southern California and southern Arizona. In southern Arizona they endure minimum temperatures of 18° F., but are severely injured by the dry winds of summer when the mercury is above 103° to 105° F. Several species of Eucalypts endure both lower and higher temperatures than these, but there are few species that do so well when subjected to extremes.

Uses.—This species is the most generally useful of all the Eucalypts. It is especially useful as a forest cover. Being adapted to such a variety of soil and climatic conditions it can be used to cover a great variety of lands Baron von Mueller says:

> For mitigating the heat of the arid treeless regions, subject to high summer temperature, *Eucalyptus globulus* plays a most important part also. But the culture of the tree should be *million fold.* * * * The rearing of forests of our Blue Gum tree can be accomplished more cheaply and more easily than that of almost any other tree, while the return is twice or three times earlier than that of the most productive Pine or Oak forests, and this raising of Eucalyptus forests can be extended to regions in which most Pines and all Oaks would cope in vain with an almost rainless clime, although Eucalyptus culture can never advance to cold zones. * * * Sterile land, unless it be absolute sand, will soon be transformed into a verdant and salubrious grove, more particularly so if substrata do not consist of impenetrable layers or outcrops of rocks. While quietly the forest advances, almost without expenditure and care, its wood treasures increase from year to year without taxing the patience of generations, and within less than half the lifetime of man timber of conspicuous dimensions can be removed after fuel has been provided annually long before, while the unpropitious original surface-soil will have been converted into a stratum of fertility for agricultural or pastoral returns from successive storage of mineral aliments brought up.

In the Southwest this species has proved to be the most useful one to plant for wind-breaks and for shade. It is also the one that has been planted most extensively for fuel and for timber. (Pl. XXIII.) It has been used for piles in several wharves on the Pacific coast with very satisfactory results. It is also the one that is used principally as the source of eucalyptus oil in California.

The timber of this tree is of a rather pale color, is hard, heavy, and very strong and durable. It is fairly straight-grained and quite easily split. In Australia it is used for shipbuilding, for carriage making, and in the manufacture of agricultural implements. It is also used in bridge building, for telegraph poles, and for railway ties. In Cali-

fornia the wood is being extensively and successfully used for insulator pins. It is also being used with success in the manufacture of parts of agricultural implements (harvesters, etc.) and the handles of plumbers' and carpenters' tools, for which purposes it is considered almost, if not quite, equal to hickory.

Eucalyptus gomphocephala.

TOOART.

Characteristics.—The tree is rather stocky and is usually symmetrical. At Mr. Ellwood Cooper's ranch it has attained a height of 80 feet in twenty-four years. (Pl. XXIV.) The bark of the trunk is dark gray, rough, and persistent. From the branches the bark flakes off in strips, leaving the surface smooth and light-colored. The twigs are reddish yellow. The leaves are thick and shining and somewhat leathery, the upper surface being darker than the lower. The flowers are of large size. The stalk of the flower clusters is flattened, the flowers themselves being stemless. The hemispheric lid of the unopened bud is broader than the part below, giving the buds the appearance of pegs, the specific name *gomphocephala* being the Greek for "peg-head." The seed cases are top-shaped, bell-shaped, or hemispherical, and are one-half to three-fourths of an inch broad. (See Pl. LXI.)

Climatic requirements.—The Tooart thrives along the coast and does fairly well in the dry interior valleys. It has not been grown extensively enough yet to determine definitely what degrees of heat and cold it will endure in America.

Uses.—The tree furnishes a heavy wood that is very tough and strong—one of the strongest timbers in the world. The grain is so close and curled or twisted that it is not easily split. The timber is used principally in shipbuilding and for bridges. It is very durable in all kinds of weather and in a great variety of situations.

Eucalyptus goniocalyx.

Characteristics.—This tree commonly attains a good size, in some situations in Australia reaching a height of 300 feet, with a diameter of 6 to 10 feet. At Mr. Cooper's ranch the trees in a grove twenty years old range from 8 to 18 inches in diameter. (Pl. XXV, A.) The bark is commonly persistent, but in some cases flakes off; the character of its surface also varies.

On the young tree, and on sprouts from the trunk, the leaves are opposite, heart-shaped or kidney-shaped, and broadly oval. (See Pl. LXXXIV, B.) The leaves of the adult trees are long and quite slender, the two sides being similarly colored. The flowers are nearly stemless, in small clusters borne on flattened stalks. The seed cases are nearly cup-shaped, and are usually more or less angled. (See Pl. LXII.)

Climatic requirements.—This species grows well in the coast regions of California, but, so far as known, it has not been tested in the dry, hot valleys of the interior, or other similar situations. In Australia it ascends to an elevation of 4,000 feet, and is therefore a promising species for the mountains of the Southwest.

Uses.—The tree furnishes a hard, tough wood used by wheelwrights, by boat builders, and for general building purposes. It is very durable in the ground and is consequently useful for railroad ties, for posts, and for other purposes in underground situations. It also makes an excellent fuel.

Eucalyptus gunnii.

CIDER EUCALYPT.

Characteristics.—The tree is usually not a tall one, but in some situations in Australia it is said to rise to a height of 250 feet. No trees growing in the Southwest, however, give promise of attaining a great height, though some of them are already 60 feet high. The trees are sometimes crooked and irregular in growth. In alpine regions they are said to be mere shrubs. The bark of the trunk is usually rough and brownish, and is continually flaking off, leaving the outer part smooth. The branches are usually smoother. The foliage is denser and darker than that of many Eucalypts, frequently being confined to the ends of the branches, however. The leaves of the young trees are roundish, and opposite on the stem (see Pl. LXXXIV, D.), and those of the adult tree are scattered and lance-shaped. They are usually shiny and more or less stiff. The flowers are of medium size and the seed cases usually nearly top-shaped. (See Pl. LXIII.)

Climatic requirements.—This species grows well near the coast and for some distance inland. It is a very hardy species, and, since in Australia it grows to an elevation of 4,000 to 5,000 feet, it ought to succeed in elevated regions of the Southwest. It endures fairly well the summer heat of the interior valleys, and during winter grows thriftily, even though the temperature fall to 20° F. each night.

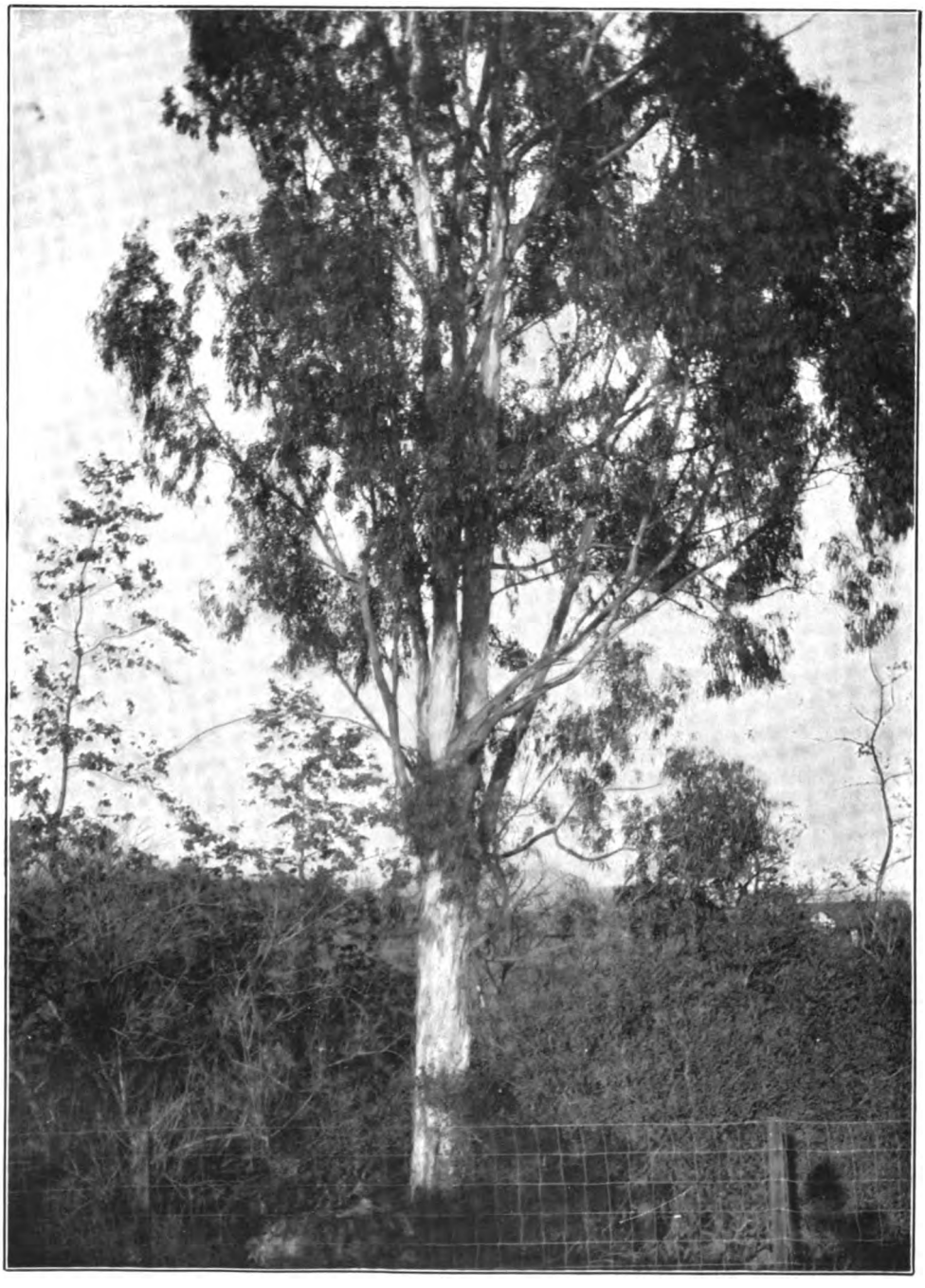
Uses.—The tree does not furnish an especially useful timber. When it grows straight it is used by artisans for many purposes, and it also makes a fair fuel. It is a very promising species as a forest cover for mountain situations not subject to high summer temperatures. The sap of the alpine form of the tree is said to be used by the aborigines of Australia for making a kind of cider.

Eucalyptus hæmastoma.

WHITE GUM.

Characteristics.—This is a tree of medium size, being usually erect and symmetrical in form. The bark is commonly smooth, but is sometimes rough and persistent. The leaves are thick, usually lance-shaped

EUCALYPTUS VIMINALIS, MONTECITO, CAL. TREES 20 YEARS OLD.



EUCALYPTUS VIMINALIS, MONTECITO, CAL. TREES 20 YEARS OLD, GROWING AMONG NATIVE SHRUBS AND TREES.

EUCALYPTUS AMYGDALINA.

EUCALYPTUS BOTRYOIDES.

EUCALYPTUS CALOPHYLLA.

EUCALYPTUS CITRIODORA.

EUCALYPTUS CORNUTA

EUCALYPTUS CORNUTA.

or sickle-shaped, but occasionally verging into a somewhat oval form. (See Pl. LXXXV, B.) They are shiny green on the two sides. The flowers are of medium size, in clusters of 5 to 7, on somewhat angular, flattened stalks. The covering of the flower buds is rounded, with an abrupt point. The fruits are cup-shaped or goblet-shaped, with brownish or reddish rims. The latter characteristic gives the tree its specific name *hæmastoma*, meaning "bloody mouth."

Climatic requirements.—This tree thrives near the coast, but is not suited in the dry interior valleys. It is said to thrive on sandy soil.

Uses.—Von Mueller and Maiden state that the wood is not of any great value for timber or fuel, but furnishes the material for fencing and for rough carpentering. It has not yet been grown extensively enough in America to determine its qualities and uses.

Eucalyptus hemiphloia.

GRAY BOX.

Characteristics.—The individuals of this species attain a fair size, the usual height in Australia being 75 to 150 feet, with a trunk diameter of 1 to 4 feet. At Cooper's ranch, Santa Barbara, it has attained a height of 80 feet and a diameter of 18 inches in twenty years. (Pl. XXVII.) The bark of the trunk is persistent and rough, but never deeply furrowed. It is usually of a grayish color. The bark of the branches commonly flakes off in long strips, leaving them smooth. The leaves are of a somewhat thick texture, varying in shape from oval to lance-shaped. They are dark green on the two sides, giving to the tree a deep green, pleasing aspect. The flowers are of medium size, in clusters of 4 to 10, on stalks that are sometimes angular. The covering of the flower buds is sharply pointed. The fruits are commonly nearly goblet-shaped. (See Pl. LXIV.)

Climatic requirements.—This Eucalypt thrives at and near the coast, on the interior foothills, and in the hot, dry valleys of the interior. It grows equally well at Pasadena, Cal., and at Phoenix, Ariz. It will endure minimum temperatures of 15° to 20°, and maximum temperatures of 110° to 115°, never having been injured in the slightest by the heaviest frosts or the hottest winds of the dry interior valleys of Arizona.

Uses.—The foliage of this tree being somewhat more dense than that of many others, it is quite useful as a shade tree. The tree furnishes a timber that is strong, hard, and close, but not easily split. The wood is used in Australia for wheelwright's work, for mauls, for handles of various implements, and for various purposes for which a tough, hard wood is used. It is very durable underground, and is consequently useful for piles, for ties, for fence posts, and for other similar objects. Baron von Mueller states that posts of this wood, after

being sixteen years in use, were found almost perfectly sound in the ground. Maiden states that it is one of the best fuel woods they have in New South Wales.

Eucalyptus leucoxylon.

SOUTH AUSTRALIAN BLUE GUM.

Characteristics.—Trees of this species attain fair size in a comparatively short time and when full grown are large. They are apt to grow out of the perpendicular and the trunks are frequently crooked. By giving them some attention when young, however, they may be made to grow erect and straight. The bark is smooth and light in color. (Pl. XXVIII.) The wood is white and quite straight grained, the former characteristic giving to the tree its specific name *leucoxylon*, the Greek for "white wood." The foliage has a pleasing bluish cast, and is well distributed over the tree. The leaves of the young seedling are broad, opposite, and stemless or short stemmed. (See Pl. LXXXVI, A.) The seedling is weak and disposed to recline on the ground in a vine-like manner. Later it assumes an approximately erect position. The leaves grow scattered and are long and slender on distinct stems, the whole aspect of the tree being quite different from that of the seedling. The flowers grow in threes on somewhat slender stems and are abundant and quite showy, varying in color from white to pink or reddish. The seed cases are somewhat egg-shaped or globular. (See Pl. LXV.)

Climatic requirements.—This tree will grow in a greater variety of climates than most Eucalypts. In fact, there are few situations in the Southwest in which it will not thrive. It grows vigorously on the coast, on the interior plains and foothills, and in the dry, hot desert valleys of the interior. It is especially thrifty at Santa Monica (Pl. XXVIII), within a few rods of the ocean, and at Phoenix, Ariz. (Pl. XXIX). It endures minimum temperatures of 15° to 20° F. In fact, the writer has never observed it seriously injured by the heaviest frosts nor the highest temperatures that occur in the desert regions of Arizona. It is one of the hardiest of the fast-growing forest trees from Australia.

Uses.—On account of its adaptability to so great a variety of climatic conditions, it can be used as a forest cover for almost all kinds of situations, and thus supply a timber useful for a large number of purposes. It can be grown for fuel and for the other purposes that the ordinary Blue Gum (*Eucalyptus globulus*) serves where the latter will not grow.

Eucalyptus longifolia.

WOOLLY-BUTT.

Characteristics.—The tree is usually shapely, and commonly attains only a moderate size, but sometimes reaches a height of 200 feet in

Australia. The trunk is straight, and its grayish, tan-colored bark is rough and persistent. (Pl. XXX.) The bark of the branches flakes off, leaving them smooth. The twigs are red or yellowish. The leaves are long (hence the specific name *longifolia*) and sickle-shaped, the two surfaces being equally green. The bloom is abundant, and is present on the tree several months of the year. The seed cases are bell-shaped and somewhat angular, usually growing in threes. They are about one-half an inch long.

Climatic requirements.—The Woolly Butt thrives near the coast, but does not endure the dry heat of some of the interior valleys.

Uses.—The timber is durable, but is not so strong and elastic as that of many of the Eucalypts. It is used for posts, for ties, for street paving, and for quite a variety of similar purposes. On account of the profuse bloom it furnishes nectar for bees, often at a time of the year when other sources are wanting.

Eucalyptus macrorhyncha.

VICTORIA STRINGY-BARK.

Characteristics.—This tree is said to attain a fair height in Australia, but the specimens growing in the Southwest do not yet give promise of attaining great size, due probably to being planted at too low an elevation. The tree has not proved to be a very symmetrical one. The bark of the trunk and branches is thick, fibrous, and persistent, usually a dark-gray color. The leaves of the young seedlings are broad and oppositely placed, the young growth being covered with short, stiff hair. The leaves of the older trees are thick and leathery, being commonly lance-shaped or somewhat sickle-shaped. The flowers are about medium size, on slender stalks, in clusters of 4 to 10. The covers of the flower buds are quite distinctly conical or long-pointed. The seed cases when fully matured are nearly spherical, with a prominent rim and protruding valves. (See Pl. LXVI.)

Climatic requirements.—This species thrives at the coast, and is said to grow in Australia on comparatively sterile mountain ranges. It is in Australia essentially a mountain species, seldom growing on the plains. It will not endure dry, hot climates.

Uses.—The bark of the tree being rough and fibrous, it is used extensively in Australia for roofing sheds, stables, and other outbuildings. Baron von Mueller states that for these purposes it will last for about twenty years. The fibers are also sometimes used for strings. The tree furnishes a wood that is hard and durable and easily split. It is useful for lumber, for fencing, and for shingles and fuel. The tree is a promising one for a forest cover for mountain ranges of the Southwest.

Eucalyptus marginata.

JARRAH.

Characteristics.—Under favorable conditions this tree grows to a large size, being commonly straight and quite slender. Few American specimens are over 30 feet high, however. The average height in Australia is said to be 100 feet, and it sometimes reaches a diameter of 10 to 15 feet there. The bark of the trunk is commonly persistent and somewhat fibrous, but sometimes flakes off in strips. The leaves vary from ovate to lance-shaped, usually somewhat curved. They vary from thin to leathery in consistence. The flowers are quite large, in clusters of 3 to 12, on conspicuous, somewhat flattened stalks. The covering to the flower bud is long and tapering. The seed cases are globular or egg-shaped, being from one-half to three-fourths of an inch long.

Climatic requirements.—In California the Jarrah does not thrive at or near the coast. In interior valleys having moderate aridity and heat it does some better, but at no point in America where it has been set does it grow with sufficient rapidity and vigor to warrant planting it for commercial purposes.

Uses.—In Australia and India the tree is prized for piles and ties. It has the reputation of being unaffected by marine boring animals and white ants. This characteristic has been thought to be due to the presence of a high percentage of kino—15 to 17 per cent—but is now considered attributable to an acid principle contained in the wood. It is also very durable under ground.

Eucalyptus melliodora.

YELLOW BOX.

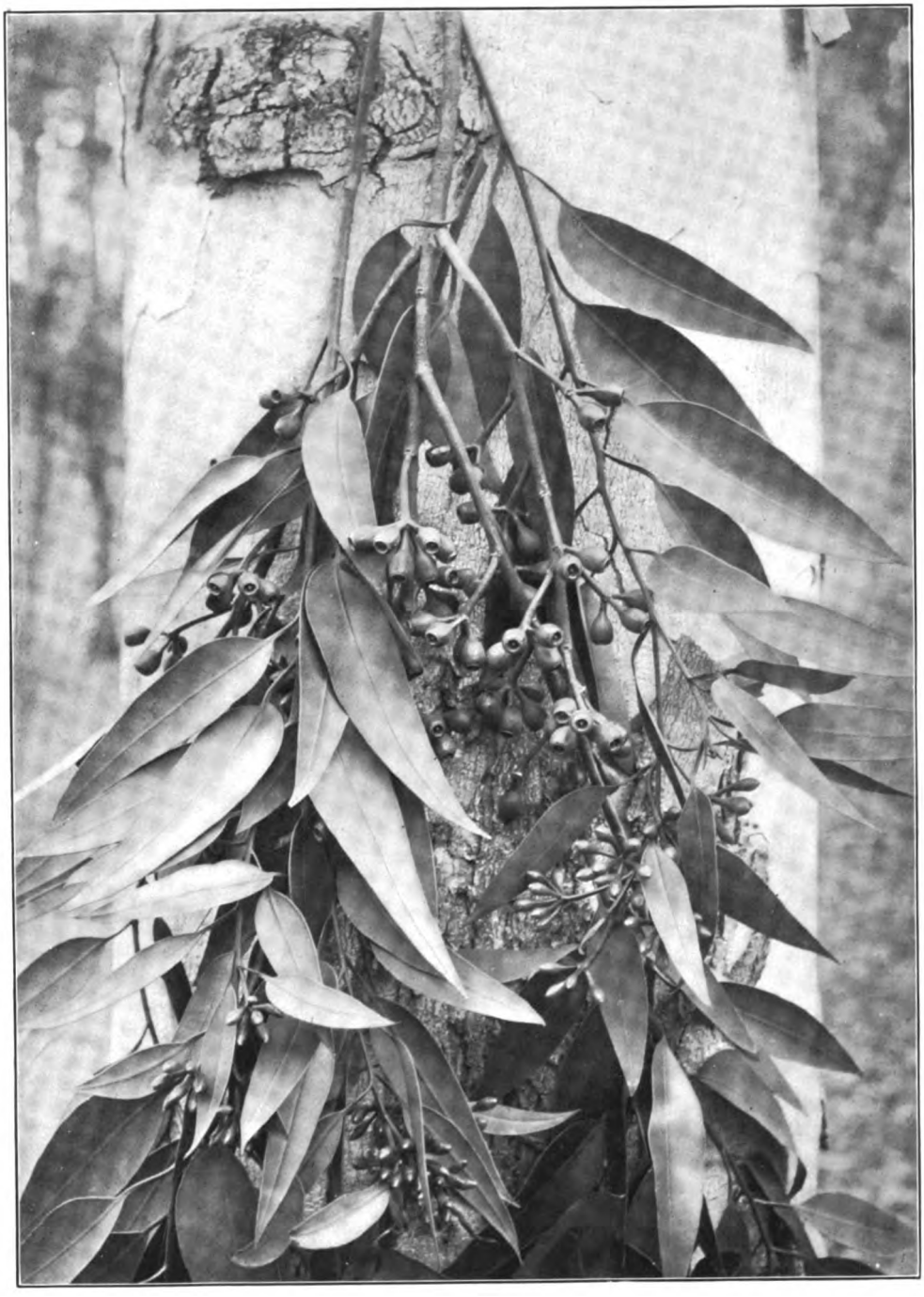
Characteristics.—The trees of this species are commonly of medium size and spreading habit, but are said occasionally to attain in Australia a height of 250 feet and a diameter of 6 to 8 feet. The trunks are commonly crooked and gnarled, the outer bark of the trunk being of a brownish-gray color and commonly persistent. (Pl. XXXI.) The inner bark is yellow, giving to the tree the name of "Yellow Box." The branches are usually quite smooth. The leaves of the young tree are often oval or oblong (Pl. LXXXVII, A), but the prevailing shape after a few years is lance or sickle shaped, both sides being of a dull-green color. The flowers are of medium size and grow in compact clusters with short stems. They emit a pleasant, honey-scented fragrance, a characteristic to which the name *melliodora* (the Latin for "honey odor") refers. The seed cases are nearly the shape of an egg with the small end cut away. (See Pl. LXVII.)

Climatic requirements.—This species will grow near the coast, on

EUCALYPTUS CORYMBOSA.

EUCALYPTUS CORYNOCALYX.

EUCALYPTUS CREBRA.



EUCALYPTUS DIVERSICOLOR.

EUCALYPTUS EUGENIOIDES.

EUCALYPTUS GLOBULUS.

EUCALYPTUS GOMPHOCEPHALA.

EUCALYPTUS GONIOCALYX.

plains and foothills, on the sides of low mountains, and in the warm, dry interior valleys. It will make some growth in the poor soil of hillsides, but prefers a fairly fertile soil. In Australia, according to Mr. Howitt and Mr. Maiden, it grows on both lowlands and highlands.

Uses.—The timber of the Yellow Box is very hard, tough, and durable, but is difficult to work and is not easily split. It is used in Australia for spokes, rollers, heavy framework, naves, and cogs. It is durable underground, and is consequently useful for telegraph poles and fence posts. It also makes an excellent fuel. On account of its profuse, fragrant bloom, it is coming to be highly prized as a source of honey.

Eucalyptus microtheca.

COOLIBAH.

Characteristics.—The Coolibah is a tree of medium size, generally more or less crooked, but of quite a pleasing appearance. The usual height in Australia is 50 to 80 feet and the diameter 2 to 4 feet. The few growing in America have quite erect trunks and give promise of becoming fair-sized trees. (Pl. XXXII.) It is one of the largest trees of the interior desert regions of Australia. The bark of the trunk is rough, generally furrowed, commonly persistent, and of a brownish-gray color (see Pl. LXVIII); that of the branches, white and deciduous. The wood is dark red or brown, and excessively hard and inlocked. The foliage is rather dense and inclined to droop. The leaves are long and somewhat curved, the two sides being equally dull green. The flowers are very small, in 3 to 8 flowered clusters, which usually grow in groups. The seed cases are very small and broadly top-shaped, with the valves protruding.

Climatic requirements.—The tree is indigenous to the dry, hot deserts of Australia, doing best in gravelly, well-drained soil. Baron von Mueller says of it, in his Eucalyptographia, that it will "brave a climatic temperature as torrid and as high as any on our planet, the thermometer rising in the shade, in places where this Eucalyptus grows, occasionally to 127° F." In his Select Extra-tropical Plants he states that it "withstands unscorched a frequent heat of 156° F." It also endures heavy frosts. It has grown well where it has been tried in the Southwest.

Uses.—As a forest cover for excessively hot, dry regions in the Southwest, this tree is quite a promising one. It furnishes a timber that is valuable for bridges, railway ties, posts, and for general building purposes. On account of the color and markings of the wood it is used for cabinetwork to some extent. The roots of this tree are used in a novel way by the natives of Australia. In common with a few other species of Eucalyptus this tree possesses water-yielding

roots, but the roots of this species yield more than those of any other. They are dug out, cut in pieces, and the water expelled by blowing at one end. According to Baron von Mueller, the aborigines depend entirely upon this source for water in many of their hunting expeditions, and frequently white settlers have found it convenient to obtain water from the same source. The planting of these trees on the deserts of the Southwest might prove a useful means of saving the lives of those crossing them.

Eucalyptus obliqua.

MESSMATE.

Characteristics.—This is a tall, straight-stemmed tree, sometimes attaining a height of 300 feet in Australia, with a stem diameter of 10 feet. The bark is fibrous and persistent on both the trunk and the branches, being of a somewhat grayish color. The leaves of the young trees are commonly broad (see Pl. LXXXVII, c), but they become narrower as the tree increases in age. They are commonly somewhat thick and stiff, and are conspicuously unequally sided toward the base. The latter characteristic causes them to set in a particularly noticeable manner obliquely to the stem, hence the specific name *obliqua*. (See Pl. LXIX.) The medium-sized flowers are very short stemmed, the stalks of the clusters being rather slender and slightly compressed. The shape of the mature seed cases is that of an egg with the smaller end cut away; or, in some cases, they are nearly hemispherical.

Climatic requirements.—This species grows fairly well at or near the coast, doing best, however, some distance inland, but it does not thrive in the dry, hot valleys of the interior. The fact that it extends well up into the mountains of Victoria and New South Wales, Australia, indicates that it is suitable for, and worthy of trial on, the lower mountains of the Southwest. It will thrive in light, barren soil, but does not endure severe drought.

Uses.—The timber of *Eucalyptus obliqua* is straight and easily split. In Australia this tree furnishes much of the hardwood lumber used for rough building purposes. It is also used extensively for fence rails, palings, and shingles. However, it does not last well underground. The bark has been used for paper making.

Eucalyptus occidentalis.

FLAT-TOPPED YATE.

Characteristics.—Individuals of this species vary considerably in habit of growth. Frequently they are shrubby in form, several stems rising from one root and growing to a height of 10 to 30 feet. (Pl. XXXIII.) Under more favorable conditions they are more tree-like,

and sometimes attain a height of over 100 feet in Australia. The bark of the trunk is in some cases smooth, in age casting off thin pieces, and in other cases quite rough and persistent. The branches are smooth and whitish, and are of about equal height, the characteristic giving the tree a flat-topped appearance. The bark of the small twigs is reddish brown. The leaves are of medium size and quite thick and shiny, the two sides being similar in appearance. (See Pl. LXXXII, c.) The flowers are large and quite conspicuous. The stalks of the clusters are flattened and the flower stems angled. The seed cases are somewhat bell-shaped or pear-shaped. (See Pl. LXX.)

Climatic requirements.—This species thrives at and near the coast, where the minimum temperatures are not below 25° F., and it endures the dry heat of the valleys, but is injured somewhat in the latter situations when the mercury falls below 25° F.

Uses.—The timber of this tree is hard and strong, and is used for fences, ties, posts, and fuel.

Eucalyptus paniculata.

WHITE IRON BARK.

Characteristics.—The trees of this species are usually below medium size, the maximum height being something over 100 feet, and in some parts of Australia growing only to a height of 25 or 30 feet. In the Southwest it has not made a promising growth, few trees being yet over 6 inches in diameter. The bark of the trunk is usually hard, rough, and of a grayish-brown color. (Pl. XXXIV.) In some cases, however, it flakes off, leaving the stem smooth and grayish in color. The leaves are of medium size, being commonly lance-shaped, or somewhat curved. The flowers are abundant, below medium size, in clusters of 3 to 8, on rather slender, angled stalks. The seed cases vary from low cup-shaped to goblet-shaped.

Climatic requirements.—This Iron Bark grows fairly well near the coast and in the mountains, but does not endure heat and drouth well. At the Santa Monica forestry station it barely survived the drouth of 1899–1900.

Uses.—This tree furnishes a timber that is hard and durable, being one of the very valuable timber trees of Australia. It is useful wherever strength, hardness, and durability are desirable.

Eucalyptus pilularis.

BLACKBUTT.

Characteristics.—This is a shapely, good-sized tree, attaining in Australia, under favorable circumstances, according to Baron von Mueller, a height of 300 feet and a diameter of 15 feet. According to Maiden, the average height is 100 to 150 feet, with a diameter of 3 to 5 feet.

In the Southwest it has made a fairly rapid growth, but does not give promise of reaching a great size. The trees are inclined to be tall and slender, with little foliage near the ground. (Pl. XXXV.) The bark of the lower part of the trunk is dark gray, rough, and partially persistent, but from most of the trunk it flakes off in patches. The bark of the branches is smooth and light colored. The twigs are often conspicuously angled. The leaves are scattered, nearly lance-shaped, and about the same color on each side. The flowers are of medium size, in clusters of 4 to 16, on scattered stalks. The flower-bud coverings are conical. The seed cases are nearly spherical, or the shape of the broad part of an egg. The round form, resembling that of a pill, suggested the specific name *pilularis*.

Climatic requirements.—The Blackbutt grows along the coast of southeastern Australia, and to some extent on inland mountain slopes. In America it grows quite thriftily at and near the coast, but does not thrive in the dry, hot interior valleys, enduring neither very high nor very low temperatures.

Uses.—The strong and durable timber of the Blackbutt is used in Australia for house carpentry, for bridge and ship building, for telegraph poles, and for railway ties. Its slender growth makes it especially suitable for telegraph poles. It is considered one of the best all around timbers furnished by any Eucalypt. Fence posts of this timber are reported to last twenty years. The tree is an excellent honey producer, the honey from it being reported to be of an especially good quality.

Eucalyptus piperita.

WHITE STRINGY-BARK.

Characteristics.—The trees of this species attain a considerable height and are commonly erect and quite shapely. The grayish bark of the trunk is fibrous and persistent. The leaves of the adult trees vary in shape from a broadly lance-shaped and very unequally sided to a narrowly lance-shaped and quite straight leaf. The young seedlings are clothed with distinct hairs. The flowers are of about medium size, in compact clusters of 6 to 12. The flower-bud coverings are cone-shaped or taper-pointed. The seed cases are the shape of the broader part of an egg or are nearly spherical.

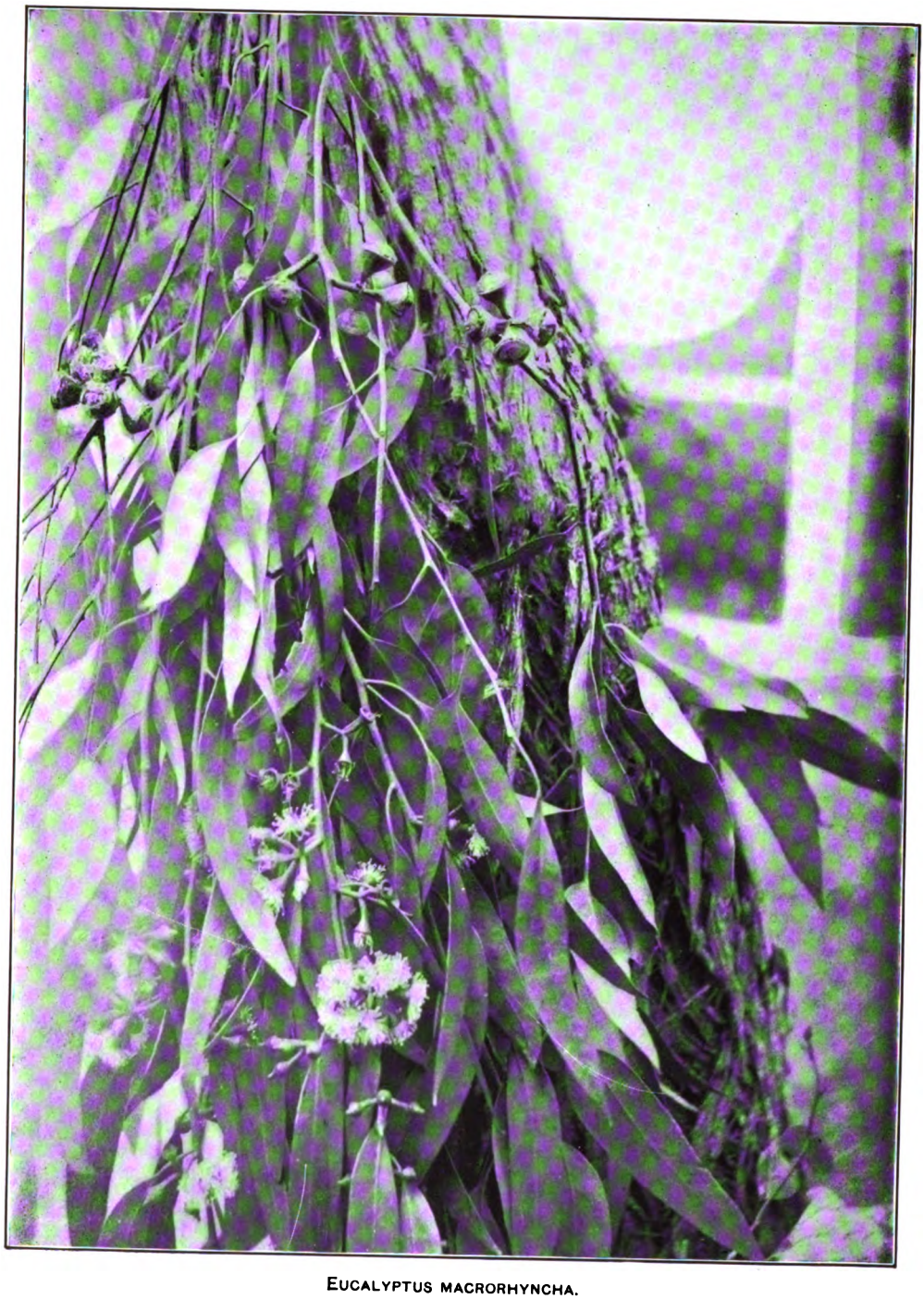
Climatic requirements.—This tree makes a fairly rapid growth near the coast and in cool inland situations, but does not endure dry, hot climates, and will not tolerate heavy frosts.

Uses.—The timber is readily split and is used for fencing and general building purposes. It is one of the species eligible for planting for a forest cover on mountain sides where it is not too dry nor subject to too heavy frosts.

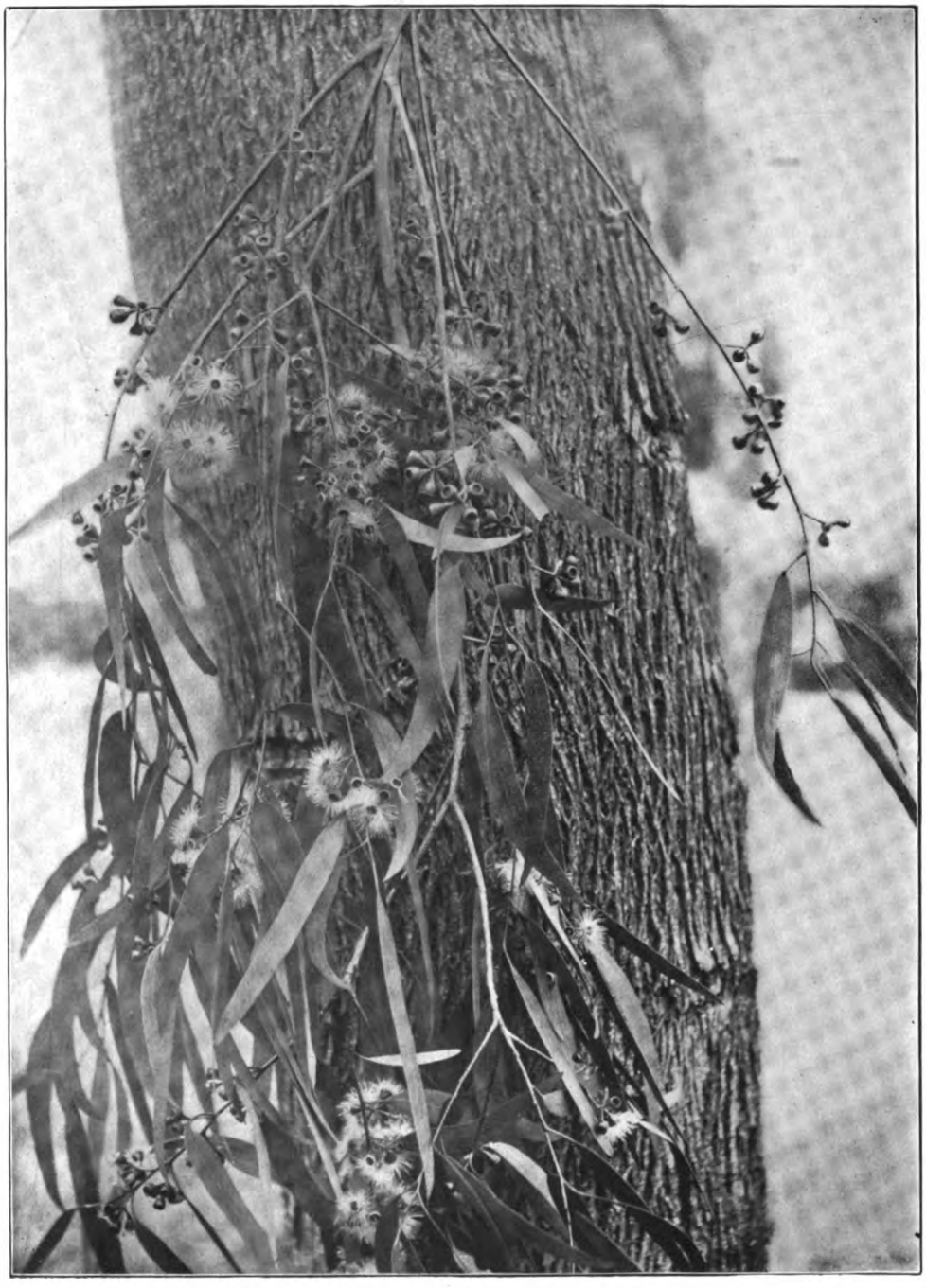
EUCALYPTUS GUNNII.

EUCALYPTUS HEMIPHLOIA.

EUCALYPTUS LEUCOXYLON.

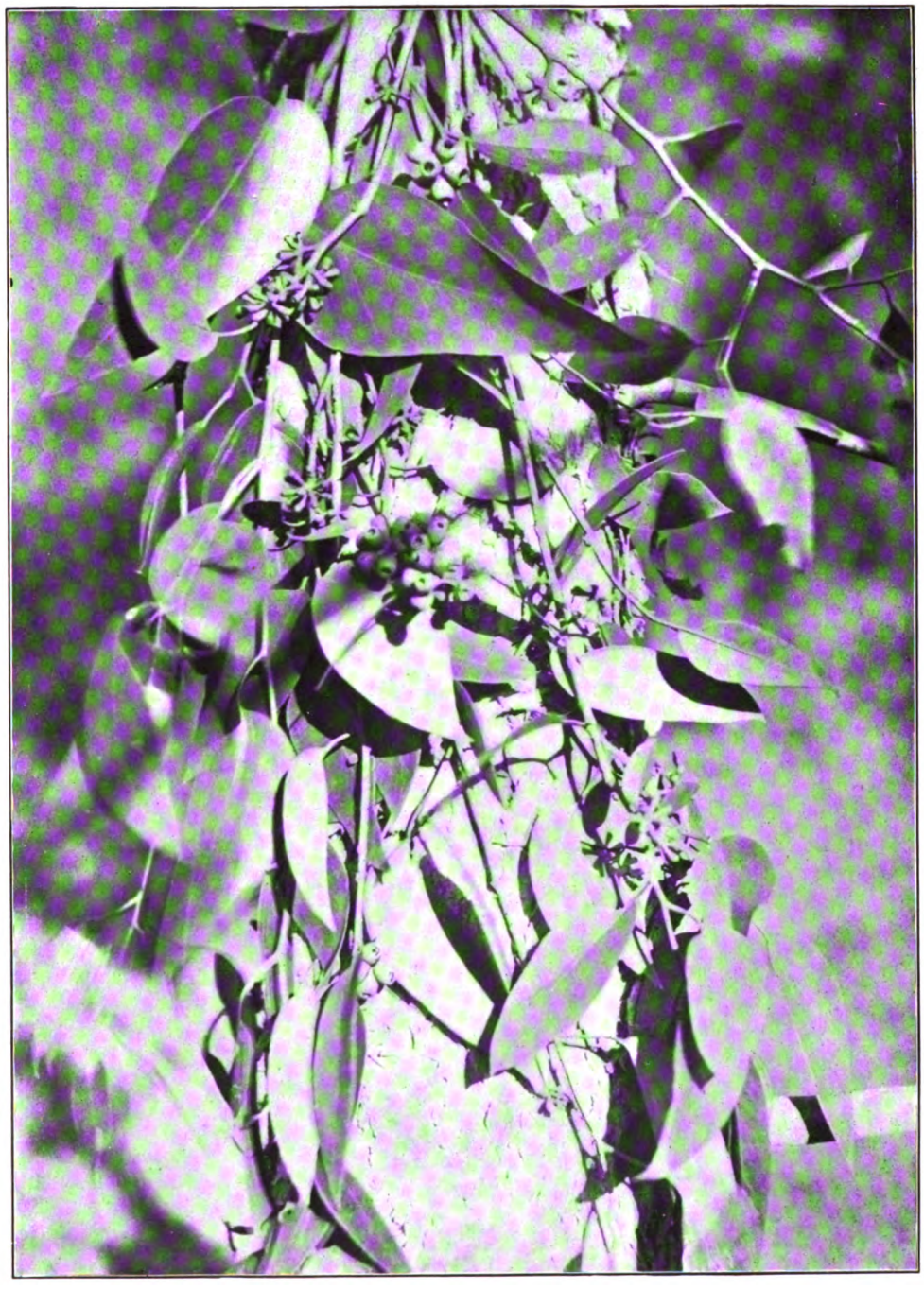


EUCALYPTUS MACRORHYNCHA.



EUCALYPTUS MELLIODORA.

EUCALYPTUS MICROTHECA.



EUCALYPTUS OBLIQUA.

EUCALYPTUS OCCIDENTALIS.

Eucalyptus polyanthema.

RED BOX.

Characteristics.—This is commonly a medium-sized tree, although it is said occasionally to reach a height of 250 feet in Australia. It is not a rapid grower, and few of the American specimens have attained a diameter of over 1 foot. It commonly sends up a single trunk, but quite frequently several stems arise from the same base. The tree is of a spreading habit, and, with its characteristic foliage and profuse bloom, presents a very pleasing appearance. (Pl. XXXVI.) The bark of the trunk and branches is persistent, somewhat furrowed, and grayish in color.

The leaves, both of the seedlings and of the adult trees, are roundish or broadly egg-shaped, and of an ashy or dull green hue on both sides. (See Pl. LXXXVII, B.) The bloom is profuse and dainty, the flowers being considerably below average size and arranged in branching clusters. (See Pl. LXXI.) The seed cases are somewhat top-shaped and, with their stems, are quite distinctly goblet-shaped. The margins are thin and often indented or split.

Climatic requirements.—This species thrives under a great variety of climatic conditions. It grows at and near the coast, in the foothills, on mountain sides, and in the hot, dry valleys of the interior. It endures minimum temperatures of 15° to 20° F. and maximum temperatures of 110° to 118° F. It is one of the few species tested at the Experiment Station farm near Phoenix that has been entirely uninjured by either the frosts of winter or the heat of summer. There are probably few situations in the Southwest below 3,000 feet elevation in which the tree would not grow.

Uses.—The timber of this tree is very hard, strong, and durable, being used in Australia for railway ties, for cogs, and for the parts of wheels. It also makes an excellent fuel. Upon account of the profuse bloom appearing at a time when sources of honey are limited, it is a useful tree for bee pasture. Its habit of growth and pleasing aspect render it a good shade tree. It can also be used as a wind-break in localities where faster growing trees will not endure the climatic conditions.

Eucalyptus populifolia.

POPLAR-LEAVED BOX.

Characteristics.—The tree is one of medium size, resembling considerably the preceding species. The bark is wrinkled and more or less furrowed, and is persistent. The leaves are scattered on rather long stalks, and are roundish or somewhat egg-shaped. They are very shiny and a deep green on both sides. The marginal vein of the leaves is some distance from the edge. The flowers are very small, in clusters

of 3 to 12 on very short stems. The stalks of the flower clusters are rather long and slender, being either single at the base of a leaf stem or in branching groups. The lid of the flower bud is hemispherical. The seed cases are very small and nearly top-shaped. (See Pl. XC.)

Climatic requirements.—This tree thrives in dry situations in California, and, judging by its Australian habitat, it could be grown even more successfully in the dry interior of the Southwest than its near relative, *Eucalyptus polyanthema.*

Uses.—This tree seems not to be sufficiently known either in Australia or in America to justify any conclusions as to its qualities or uses. It is reported to furnish durable posts, and probably in all its qualities closely resembles *Eucalyptus polyanthema.*

Eucalyptus punctata.

LEATHER-JACKET.

Characteristics.—The tree is of medium size, attaining in Australia a height of about 100 feet. It has a spreading habit, especially when young, not possessed by many Eucalypts. The bark is rough and of a dark color, and has a tendency to flake off. The leaves are lance-shaped or sickle-shaped, and thin. (See Pl. LXXXVIII, B.) The under surface is somewhat paler than the upper shiny one. The flowers are above medium size, in clusters of 3 to 10 on rather stiff, flattened stalks. The shape of the seed cases is nearly that of the broad part of an egg.

Climatic requirements.—This species thrives at and near the coast, but does not do as well in the dry interior.

Uses.—The wood of this tree is tough, hard, close-grained, and very durable. It is useful for fence posts, railway ties, and for the parts of wheels. It also makes an excellent fuel.

Eucalyptus resinifera.

RED MAHOGANY.

Characteristics.—This is a tree of fair size, when full grown, reaching a height of 100 feet. It is usually erect and symmetrical. The bark of the trunk is dark reddish, fibrous, and persistent, resembling considerably that of the Stringy barks. The bark of the branches is more or less deciduous. The wood is a rich, red color resembling true mahogany, and is very heavy. The leaves are slender and usually somewhat curved. (See Pl. LXXXVIII, A.) They are somewhat leathery in texture, and are considerably paler beneath than above. The veins spread like the parts of a feather. The flowers are of about medium size, in clusters of 4 to 10, on a somewhat compressed stalk. The buds are distinctly cream-colored, the lids being conical, with tapering points. The seed cases are cup-shaped or bell-shaped. (See Pl. LXXII.)

Climatic requirements.—The Red Mahogany grows quite well in the coast region of California, but does not thrive in the dry interior valleys. It does not resist severe frost, nor does it endure high temperatures in a dry atmosphere. It is well suited to moist, semitropical climates, being confined in Australia almost exclusively to the warm coast districts.

Uses.—The tree furnishes a timber that is very strong, hard, and durable. It is used in Australia for piles, posts, paving, shingles, and general building purposes. Mr. Maiden says in his "Useful Australian Plants:"

> This is one of the most valuable hard woods of the colony [New South Wales]. It is a rich red color, resembling true mahogany a good deal in appearance. It is a grand furniture wood where its weight is not against it. * * * It is one of the most durable timbers we have, being greatly resistant to damp and the attacks of white ants.

This Eucalypt can be used as a forest cover, as a shade tree, and as a wind-break where it is too moist and warm for other species, and will at the same time be a source of valuable timber.

Eucalyptus robusta.

SWAMP MAHOGANY.

Characteristics.—This is a tree symmetrical in form and of medium size. In the Southwest it has not yet exceeded a height of 50 feet and a diameter of 1 foot, but in Australia it is said to attain a height of 100 feet, with a trunk sometimes 50 feet long and nearly 4 feet in diameter. The heavy foliage and spreading habit give the tree a stately, robust appearance, hence its specific name, *robusta*. (See Pl. XXXVII.) The rusty gray bark is persistent and is usually wrinkled and furrowed. The bark of the branches frequently flakes off, leaving them smooth. The leaves are large and leathery, sometimes being 6 inches long and 2 inches wide. (See Pl. LXXIII.) The upper side is dark green, the lower a paler green color. The cream-colored flowers are large and quite abundant, growing in clusters of 3 to 10 on stout, usually flattened stocks. The seed cases are goblet-shaped, or sometimes urn-shaped, and occasionally slightly angled. (See Pl. XCI.)

Climatic requirements.—The tree thrives at and near the coast, but does not endure well the dry heat of the interior. In its native country it grows in warm, swampy coast localities, but in the Southwest it will grow in quite a variety of situations if supplied with sufficient water. It has been much planted as an avenue tree in the Southwest, but after a few years it usually makes an irregular, unsatisfactory growth, unless the roots are kept quite moist. It ought to thrive along the coast of the Gulf of Mexico, in regions free from heavy frosts.

Uses.—The wood of this tree is not in special favor with artisans; but as it is durable underground it is very useful for posts, ties, and similar purposes. According to Baron von Mueller it is free from the attacks of destructive insects, which is ascribable to the presence of kino.

Eucalyptus rostrata.

RED GUM.

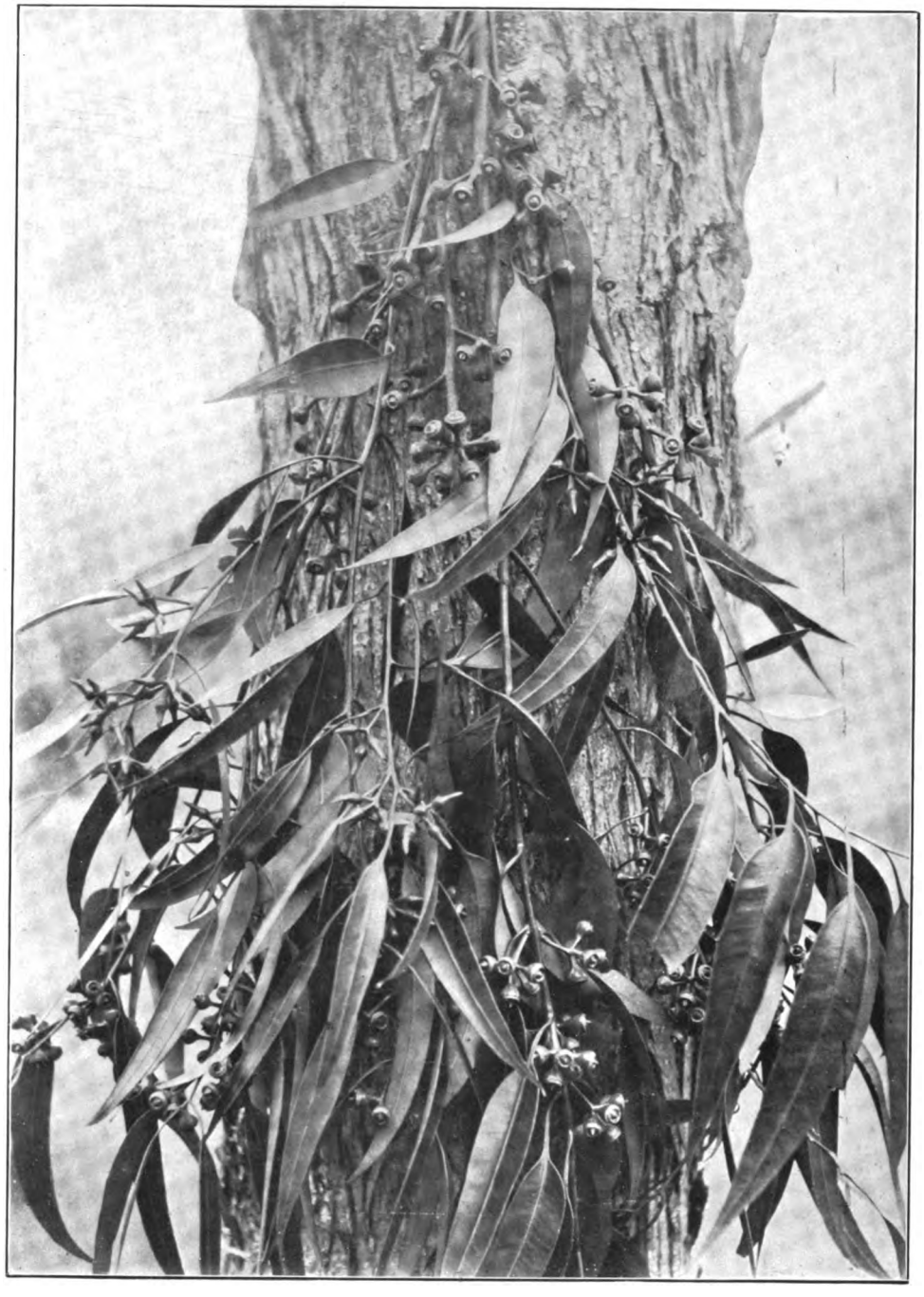
Characteristics.—Individuals of this species make fairly rapid growth, and are commonly above medium size. The tree varies considerably in habit and appearance, in some cases being erect and stately, and in other cases unsymmetrical and irregular in growth. (Pls. XXXVIII, XXXIX.) The individuals also vary as to the hue of the foliage, that of some being a livid green, while that of others may be yellowish or reddish.

The Red Gum is one of the leading forest trees of the Australian continent. Baron von Mueller says of it that it is "perhaps the most important of the whole genus!" Mr. Maiden says, "I do not suppose that there is a person resident in Victoria or South Australia for six months who does not well know what Red Gum is;" and, in speaking of its occurrence in New South Wales, adds, "It is the tree which produces directly to the colony by far the most revenue of all our trees."

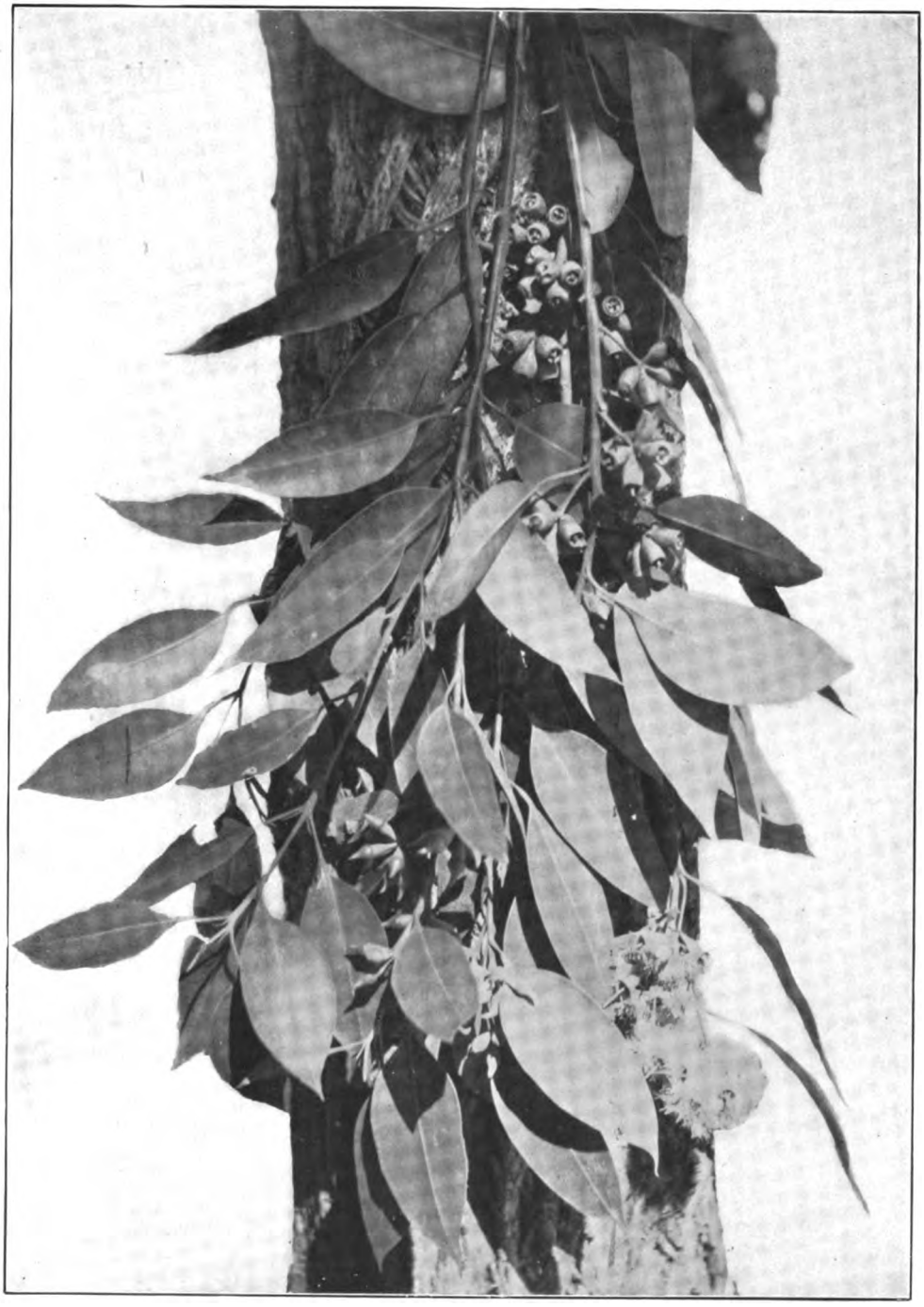
The tree is commonly about 100 feet high in Australia, but is reported under favorable circumstances to grow to double that height, with a trunk diameter of 6 to 12 feet. The bark of the younger trees is smooth and reddish or ashy gray; of the older ones usually more or less rough and furrowed. It is commonly persistent, but occasionally patches of varying thickness flake off. The stems of the young seedlings and the twigs of the trees are red. The leaves are of medium size, lance-shaped or sickle-shaped, and have the same color on the two sides. The flowers are small, on slender stems, in clusters of 3 to 12, borne on rather slender stalks. The deciduous covering of the flower bud is distinctly pointed or beaked, the Latin word for which is *rostratus*, giving the tree its specific name. The seed cases are cup-shaped, with conspicuous protruding valves. (See Pl. LXXIV.)

Climatic requirements.—The Red Gum grows under a great variety of climatic conditions. It is scattered over most of the southeastern part of Australia, growing there in a great variety of situations. While it prefers moist river bottoms with an equable climate, it will endure much heat, severe frost, and considerable drought. In the southwestern part of the United States it thrives at the coast, on the dry mesas, in the foothills, and in many of the dry, hot valleys of the interior. In the latter region it endures minimum temperatures of 15° to 20° F., and maximum temperatures of 110° to 115° F. It thrives in the moist, foggy sections of the coast regions of the Southwest, and

EUCALYPTUS POLYANTHEMA.



EUCALYPTUS RESINIFERA.



EUCALYPTUS ROBUSTA.

EUCALYPTUS ROSTRATA.

endures the desert conditions of southern Arizona. Near Phœnix, where the annual rainfall is only 7 inches, are trees that in ten years have attained a height of 30 to 45 feet and a basal diameter of 1 foot, with no irrigation since the first few years of their growth. (See Pls. XL, XLI.) Besides enduring such extreme climatic conditions as indicated, this species is also tolerant of considerable alkali.

The Red Gum seems to have become more nearly naturalized in the Southwest than any other species. As already stated, it grows spontaneously in considerable abundance on Mr. Cooper's ranch near Santa Barbara, the climatic and soil conditions of the ravine that extends through his estate seeming to resemble quite closely conditions under which the tree thrives in its native land. As the species becomes more generally planted it will, very probably, come to grow spontaneously under a variety of conditions.

Uses.—The Red Gum furnishes a timber that is very valuable for many purposes. When freshly cut, the wood is a rich red color that grows darker as it is exposed to the air. It is close-grained, the fibers being interlocked and thus rendering it quite difficult to split. It is very hard and strong—Mr. Maiden says "almost as hard as iron, when thoroughly dry." The great usefulness of the timber is due principally to its durability, both underground and in water. Baron von Mueller says, in his "Introduction to Botanical Teachings," that "well matured trees of this species, cut at the season when the circulation of the sap is least active, and carefully placed for drying, have proved one of the most durable of any timbers of the whole globe." According to this author and Mr. Maiden, the principal uses of the timber in Australia are for ship building, for bridge building, for paving, for telegraph poles, posts, piles, house blocks, and street curbing. It is reported to be quite resistant to the attacks of marine animals and white ants. Baron von Mueller says, "The timber is one of the most highly esteemed in all Australia among that of Eucalypts;" and Mr. Maiden, in speaking of this species in an address upon the forests of New South Wales, May, 1901, states that "there is no difficulty in supplying a practically unlimited demand for a timber of one uniform quality."

In Australia the Red Gum is a source of commercial kino, the article from this species being, according to Mr. Maiden, "perhaps the best known of all Eucalyptus kinos." Exudations are provoked by chopping a few chips from the bark of the trunk.

In America the principal uses made of the Red Gum have been for fuel and for posts. Mr. Cooper cuts it for fuel for home use and for market, and considers it a profitable species for that purpose. On account of its profuse bloom it is a good honey-yielding tree, both in Australia and in America. Besides the above, the species is useful as a shade tree, as a wind-break, and as a forest cover in a great variety

of situations. Owing to the great value of the tree from so many standpoints, no mistake will be made in setting it wherever it will thrive. It may be planted with profit as a forest cover in ravines, on hillsides, on plains, and in quite dry desert situations. Such plantations will within a decade begin to be sources of posts, fuel, railway ties, telegraph poles, and bridge timbers, and will eventually produce timber suitable for other important uses. If such plantings were made along railway tracks, ties for keeping them in repair would be available within a decade, and later the product would be sufficient for extensions of the road into new sections. Timbers for repairing railway bridges and building new ones, as well as for telegraph poles, could also be thus supplied within easy reach of the points where they would be needed.

Eucalyptus rudis.

Characteristics.—The trees of this species are commonly of medium size, the usual height being 50 to 75 feet. Near Fresno, Cal., a grove fifteen years of age contains trees 70 to 80 feet high and 18 to 24 inches in diameter. (Pls. XLII, XLIII.) The trees differ in habit, most being erect and stately, while occasionally others have drooping stems and branches. The young trees are vigorous and rapid growers, attaining in America half the maximum height reported for them from Australia in four or five years. The grayish bark of the trunk is usually rough and persistent, but sometimes flakes off, leaving the trunk smooth. The leaves of the young trees are oblong, or sometimes roundish, often with a deep red or bronze hue. (See Pls. LXXXIV, A; LXXXIX, A.) As the tree grows older the new leaves are longer and thinnish, finally being lance-shaped or curved. (See Pls. LXXV, LXXVI.) The flowers are about medium size, in clusters of 3 to 8, on rather slender stalks. The covering of the flower buds is conical. The seed cases are cup-shaped, with prominent protruding valves.

Climatic requirements.—If supplied with sufficient water the tree will thrive in quite a variety of climates. In Australia it grows naturally along or near streams. In the Southwest it thrives near the coast, on dry mesas, and in the hot valleys of the interior. At Phoenix, Ariz., one tree has attained a height of 30 feet and a diameter of 6 inches in three years, being unaffected by either the heat of summer or the cold of winter. In the Southwest the tree has proven to be remarkably hardy to heat and cold, enduring without injury minimum temperatures of 15° to 18° F. and maximum temperatures of 110° to 118° F.

Uses.—Few reports on the character of the timber and its uses in Australia are available, and the tree has not been grown extensively enough in America to obtain data on the subject here. In regions

where less hardy species can not be grown the species will be useful for shade, for wind-breaks, for fuel, and for honey. It may also prove useful for posts.

Eucalyptus saligna.

Characteristics.—A lofty, straight-stemmed tree, the usual height in Australia being 100 to 200 feet and the diameter 3 to 6 feet. No large trees of this species are known to exist in America, and those that have been set have not given promise of attaining great size. The bark of the trunk is grayish in color, and is rendered nearly smooth by the gradual flaking off of the outer layers. The leaves are lance-shaped, somewhat curved, and long-pointed, the lower side being paler than the upper. The flowers are of medium size, nearly stemless, in clusters of 4 to 8, on a much-flattened stalk. The covering of the unopened flower buds is nearly cone-shaped. The seed cases are commonly bell-shaped, with protruding valves.

Climatic requirements.—This species has not been planted extensively enough in America for its relation to climate to be established. Very few of the trees that had been planted survived the drought of 1897–1900 in the Southwest. In Australia this species is confined to the warmer coast regions; hence it could not be expected to endure very severe conditions in America.

Uses.—In Australia this tree is one of the important sources of lumber. The timber is reported to have great strength and durability. It is used for piles, for large beams, for railway ties, and for other purposes where strength and durability are important. The wood is a pale, reddish color, is straight-grained, and is easily worked. It is said by Mr. Maiden to be a favorite with carpenters, who use it for a great variety of building purposes. It is also used by shipwrights and by wheelwrights.

Eucalyptus siderophloia.

BROAD-LEAFED IRONBARK.

Characteristics.—The trees of this species attain in Australia a height of 100 feet or more, with a trunk diameter of 3 to 4 feet; and in the Southwest they give promise of growing to a fair size. As of other Ironbark Eucalypts, the bark is persistent and rough, with quite deep fissures. It is of a rusty color and somewhat flaky. (See Pl. XLIV.) The leaves are large and broad, usually rather thick, often much curved, and are of about the same color on the two sides. (See Pl. LXXXIII, A.) The flowers are of about medium size, in clusters of 2 to 8 on more or less angled stalks. The clusters grow either singly or in groups of 2 to 8, mainly at the ends of the twigs. (See Pl. LXXVII.) The long covering of the flower-bud is conical and sharp pointed. The seed cases with their stems are goblet-shaped.

Climatic requirements.—This species grows fairly well in quite a variety of situations in the coast region of California, but will not thrive in the dry, hot valleys of the interior. It will endure minimum temperatures of 18° to 20° F., and maximum temperatures of 110° to 112° F., but it makes very slow growth under such trying conditions.

Uses.—The timber of the Broad-leafed Ironbark, as of other Ironbarks, is strong and durable. It is used for bridge building, for posts, sleepers, railway ties, and for other similar purposes where strength and durability are desired. It makes a fair fuel, burning very slowly.

Eucalyptus sideroxylon.

RED IRONBARK.

Characteristics.—The Red Ironbark is a tree of medium to large size. It usually grows erect, with an even trunk, having numerous side branches, especially towards the top. It never grows to a great height. The bark is the hardest and darkest of the Ironbarks, the color usually being a dark red or brown. It is furrowed and cracked, and studded with beads of the kino that exudes from it. The whole appearance of the tree, with its rough, dark bark, its silvery, narrow leaves, and daintily colored flowers is quite distinctive, contrasting strongly with the smooth-barked, broader-leafed species of the genus. (Pl. XLV.) The wood is a dark red, and is very hard and heavy. The leaves are narrowly lance-shaped, often curved, and usually have a more or less evident silvery surface, the leaves of the seedlings being very similar to those of the adult tree. (See Pl. LXXXVI, B.) The flowers are somewhat above medium size, in clusters of 3 to 8. In color they vary from a light pink to scarlet. The covering of the flower-bud is cone-shaped, often sharp-pointed. The seed cases are nearly cup-shaped. (See Pl. LXXVIII.)

Climatic requirements.—In Australia the Red Ironbark is most abundant on the stony, sterile portions of gold-producing districts, enduring considerable drought and heat. In California it thrives in dry soil near the coast, and on the plains and hillsides of many of the interior valleys. It endures minimum temperatures of 16° to 20° F., and maximum temperatures of 110° to 112° F., but makes a very slow and indifferent growth under such conditions. It has proven to be entirely unsuited to the hot, interior valleys of California and Arizona.

Uses.—The Red Ironbark is one of the very useful Eucalypts. While the timber is not prized as highly in Australia as that of other Ironbarks, it is nevertheless valuable for many purposes. Its principal uses are for bridge construction, for railway ties, for girders and large beams in buildings, for joists, for posts, for the hubs, spokes, and shafts of vehicles, and for a great variety of other purposes where strength and durability are required. On account of its shape and

EUCALYPTUS RUDIS. TREE 12 YEARS OLD.

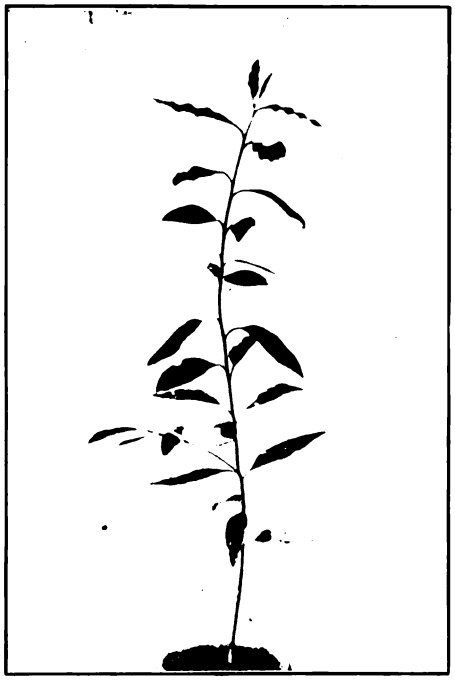
EUCALYPTUS RUDIS. TREE 6 YEARS OLD.

EUCALYPTUS SIDEROPHLOIA.

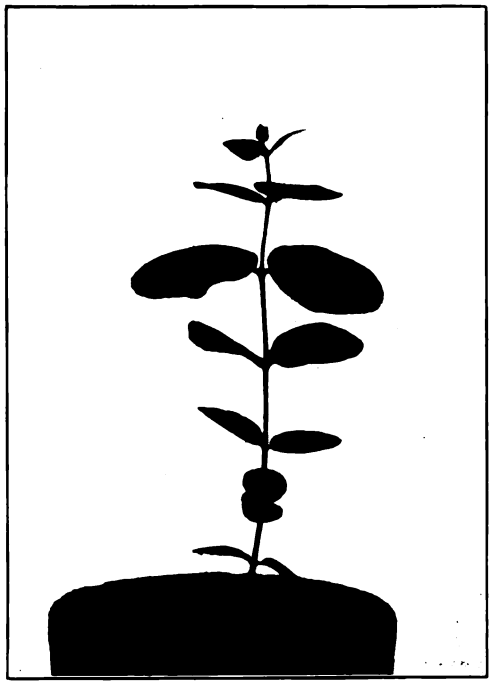
EUCALYPTUS SIDEROXYLON.

EUCALYPTUS TERETICORNIS.

EUCALYPTUS VIMINALIS.

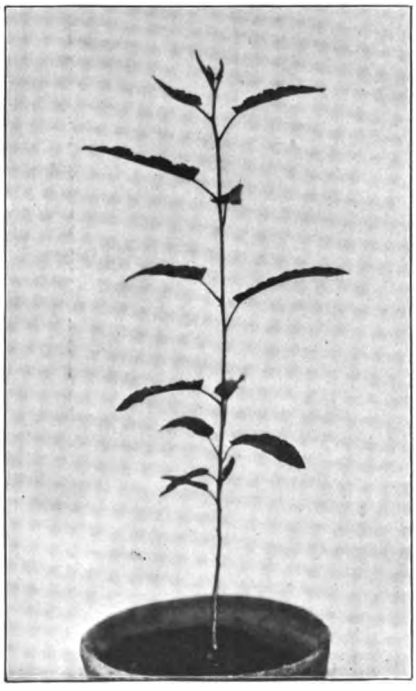


A. EUCALYPTUS CALOPHYLLA.



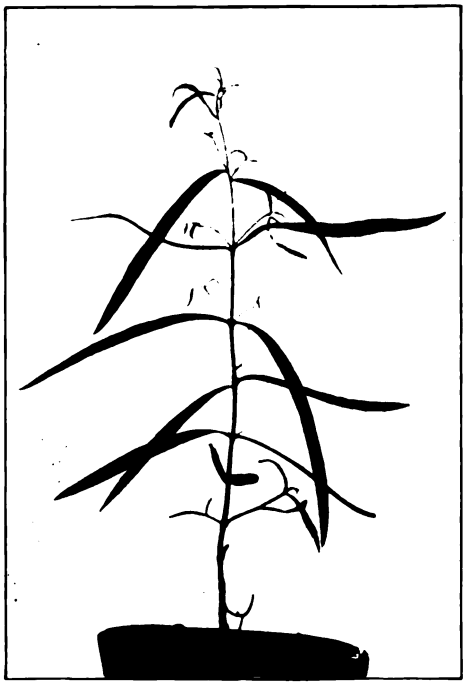
B. EUCALYPTUS CORYMBOSA.

C. EUCALYPTUS CORYNOCALYX.



D. EUCALYPTUS CITRIODORA.

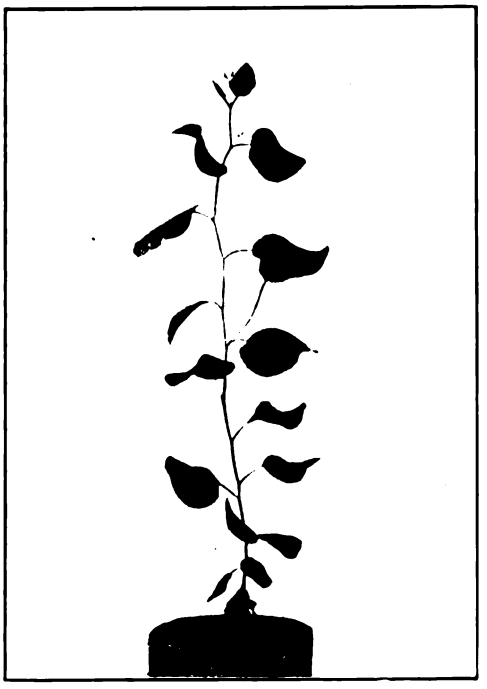
EUCALYPT SEEDLINGS.



A. EUCALYPTUS CORIACEA.

B. EUCALYPTUS EUGENIOIDES.

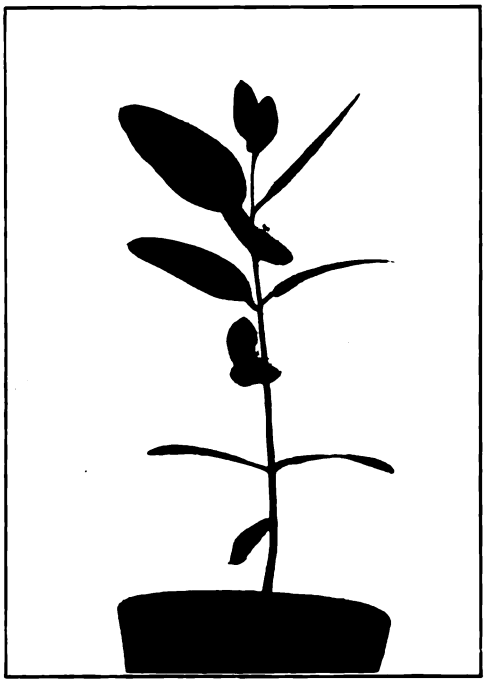
C. EUCALYPTUS OCCIDENTALIS.



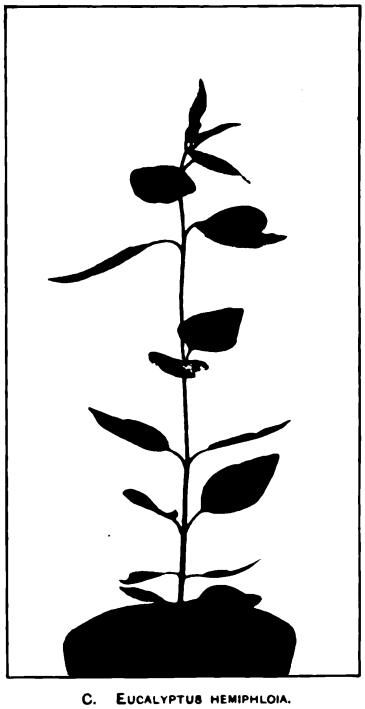
D. EUCALYPTUS CORNUTA.

EUCALYPT SEEDLINGS.

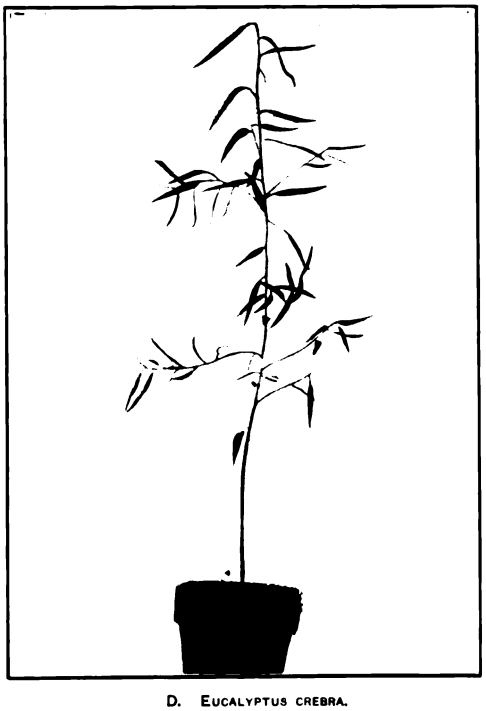
A. EUCALYPTUS PANICULATA.



B. EUCALYPTUS HAEMASTOMA.

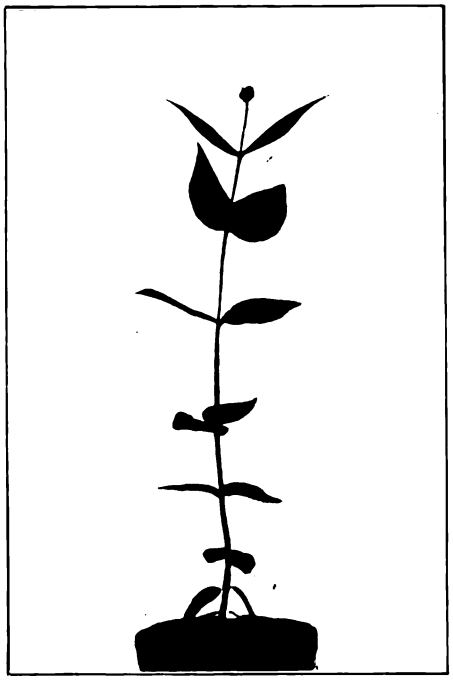


C. EUCALYPTUS HEMIPHLOIA.



D. EUCALYPTUS CREBRA.

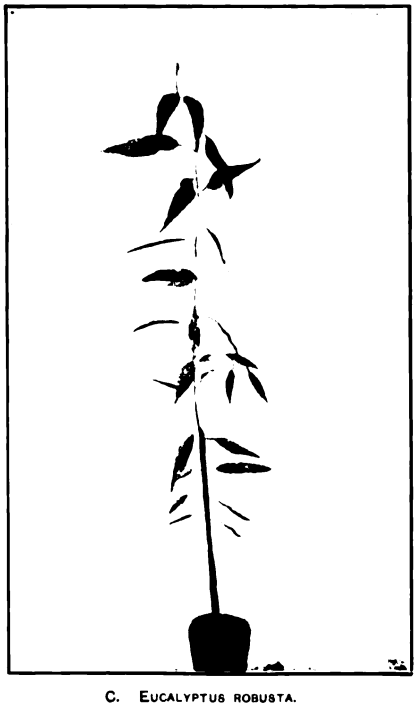
EUCALYPT SEEDLINGS.



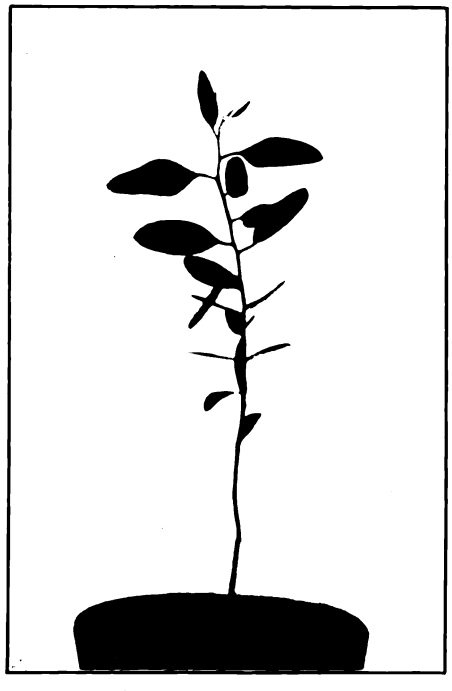
A. EUCALYPTUS LEUCOXYLON.

B. EUCALYPTUS SIDEROXYLON.

On account of the similarity of the flowers and seed cases, these two species were confused in herbaria for many years.



C. EUCALYPTUS ROBUSTA.



D. EUCALYPTUS LONGIFOLIA.

EUCALYPT SEEDLINGS.

agreeing in one characteristic, differ considerably among themselves in other respects, especially in the shape of the leaves. None of these species have permanently opposite or stemless leaves.

Leaves of seedlings hairy: *Eucalyptus calophylla*, *E. citriodora*, *E. coriacea*, *E. eugenioides*, *E. macrorhyncha*, and *E. paniculata*.

Leaves permanently horizontal, darker above than below: *Eucalyptus botryoides*, *E. calophylla*, *E. corymbosa*, *E. diversicolor*, *E. resinifera*, *E. robusta*, and *E. saligna*. The foregoing species being all indigenous to the moister regions of Australia, the characteristic placing of the leaves vertically is not necessary. A few species, including *E. corynocalyx*, *E. diversicolor*, *E. pilularis*, and *E. punctata*, while not having their leaves so distinctly permanently horizontal, have leaves with the two surfaces more or unless unlike.

FLOWERS AND SEED CASES.

Flowers commonly in threes: *Eucalyptus leucoxylon*, *E. longifolia*, *E. viminalis*.

Flower clusters borne on a distinctly flattened stalk: *Eucalyptus botryoides*, *E. gomphocephala*, *E. goniocalyx*, *E. occidentalis*, *E. punctata*, *E. resinifera*, and *E. saligna*.

Flower-bud covering long and prominent: *Eucalyptus cornuta*, *E. marginata*, *E. occidentalis*, *E. siderophloia*, and *E. tereticornis*.

Seed cases large (one-half inch to 1½ inches in diameter): *Eucalyptus calophylla*, *E. corymbosa*, *E. globulus*, *E. gomphocephala*, *E. longifolia*, *E. marginata*, and *E. robusta*.

Seed cases very small (one-tenth to one-sixth inch in diameter): *Eucalyptus crebra*, *E. microtheca*, *E. polyanthema*, and *E. populifolia*.

CLIMATIC ADAPTATION.

In the following paragraphs an attempt is made to list species especially adapted to various climatic situations. It is not claimed that all that may be grown successfully in any one region are listed, but it is thought that the more promising ones are included.

Adapted to hot, humid regions: *Eucalyptus botryoides*, *E. calophylla*, *E. citriodora*, *E. cornuta*, *E. marginata*, and *E. resinifera*. Of the above, *E. botryoides*, *E. citriodora*, and *E. resinifera* are the most likely to thrive in America and to produce useful timber.

Adapted to warm, moderately humid regions having light winter frosts: *Eucalyptus amygdalina*, *E. botryoides*, *E. cornuta*, *E. corymbosa*, *E. corynocalyx*, *E. crebra*, *E. diversicolor*, *E. globulus*, *E. gomphocephala*, *E. goniocalyx*, *E. occidentalis*, *E. robusta*, *E. rostrata*, *E. rudis*, *E. sideroxylon*, *E. tereticornis*, and *E. viminalis*. Of the foregoing, *E. botryoides*, *E. diversicolor*, *E. globulus*, *E. gomphocephala*, and *E. tereticornis* seem best adapted to American climatic conditions, and most suitable for producing timber valuable for commercial purposes.

Adapted to situations not excessively warm during summer, but frosty during winter: *Eucalyptus amygdalina*, *E. crebra*, *E. eugenioides*, *E. gunnii*, *E. macrorhyncha*, *E. obliqua*, *E. leucoxylon*, *E. piperita*, *E. polyanthema*, *E. rostrata*, *E. rudis*, *E. saligna*, *E. stuartiana*, and *E. tereticornis*. Of these species *E. gunnii*, *E. leucoxylon*, *E. polyanthema*, *E. rudis*, and *E. tereticornis* will be most likely to give good results in the Southwest.

Adapted to dry regions free from heavy frosts: *Eucalyptus corynocalyx*, *E. crebra*, *E. diversicolor*, *E. globulus*, *E. gomphocephala*, *E. goniocalyx*, *E. leucoxylon*, *E. longifolia*, *E. pilularis*, *E. polyanthema*, *E. rostrata*, *E. rudis*, *E. sideroxylon*, *E. tereticornis*, and *E. viminalis*. Of the foregoing species *E. corynocalyx*, *E. crebra*, *E. diversicolor*, *E. globulus*, *E. leucoxylon*, *E. polyanthema*, *E. sideroxylon*, and *E. tereticornis* should give the best results in America and produce the most valuable timber.

Adapted to moderately moist mountain situations: *Eucalyptus coriacea*, *E. eugenioides*, *E. gunnii*, *E. leucoxylon*, *E. obliqua*, *E. piperita*, *E. rudis*, and *E. stuartiana*.

Adapted to regions dry and hot during summer and frosty during winter: *Eucalyptus corynocalyx*, *E. hemiphloia*, *E. leucoxylon*, *E. microtheca*, *E. polyanthema*, *E. rudis*, *E. tereticornis*, and *E. viminalis*.

Adapted to cultivation on alkali soils: *Eucalyptus cornuta*, *E. robusta*, and *E. rostrata*.

USES.

An attempt is made in the following pages to group the species of Eucalypts growing and fruiting in America according to the useful purposes for which they may be raised. It is not probable that all the species useful for any given purpose are included under the respective headings, but it is hoped that the most desirable ones have been noted. In selecting a species to grow for any given purpose, the question must be raised and answered as to whether it will be likely to thrive in the region where it is to be planted.

Useful for forest cover: (1) For mountains: *Eucalyptus coriacea*, *E. eugenioides*, *E. gunnii*, *E. leucoxylon*, *E. macrorhyncha*, *E. obliqua*, *E. piperita*, and *E. stuartiana*. (2) For plains and hills: *E. cornuta*, *E. corynocalyx*, *E. crebra*, *E. diversicolor*, *E. globulus*, *E. leucoxylon*, *E. rostrata*, *E. rudis*, *E. sideroxylon*, *E. tereticornis*, and *E. viminalis*. (3) For lowlands: *E. botryoides*, *E. citriodora*, *E. globulus*, and *E. robusta*. (4) For deserts: *E. corynocalyx*, *E. hemiphloia*, *E. leucoxylon*, *E. microtheca*, *E. polyanthema*, *E. tereticornis*, and *E. viminalis*.

Useful for wind-breaks: *Eucalyptus cornuta*, *E. globulus*, *E. leucoxylon*, *E. polyanthema*, *E. rostrata*, *E. rudis*, *E. sideroxylon*, *E. tereticornis*, and *E. viminalis*.

Since rapidity of growth is an important factor to be considered in

setting a wind-break, *Eucalyptus globulus*, *E. rudis*, *and E. viminalis* would be the most satisfactory ones of the above list. One of the three can be grown in most situations where a wind-break would be desired.

Useful for shade: *Eucalyptus botryoides*, *E. cornuta*, *E. corynocalyx*, *E. diversicolor*, *E. globulus*, *E. hemiphloia*, *E. leucoxylon*, *E. melliodora*, *E. polyanthema*, *E. robusta*, *E. rudis*, and *E. viminalis*. As there are few situations in the settled portions of the Southwest where one or more of the above will not grow, settlers may all have the pleasure of the shades of an evergreen wherever they may be located in that part of the United States.

Useful for fuel: *Eucalyptus botryoides*, *E. coriacea*, *E. corynocalyx*, *E. diversicolor*, *E. macrorhyncha*, *E. melliodora*, *E. obliqua*, *E. occidentalis*, *E. polyanthema*, *E. resinifera*, *E. rostrata*, *E. stuartiana*, and *E. tereticornis*.

Useful for posts, railway ties, and other underground purposes: *Eucalyptus botryoides*, *E. corymbosa*, *E. corynocalyx*, *E. crebra*, *E. eugenioides*, *E. goniocalyx*, *E. hemiphloia*, *E. longifolia*, *E. melliodora*, *E. microtheca*, *E. paniculata*, *E. pilularis*, *E. polyanthema*, *E. punctata*, *E. resinifera*, *E. robusta*, *E. rostrata*, *E. rudis*, *E. siderophloia*, *E. sideroxylon*, *E. stuartiana*, and *E. tereticornis*.

Judging from inquiries received by the writer and from statements made by farmers, there are few more important purposes that the Eucalypts are likely to serve than that of furnishing fence posts. From the above list one or more can be selected that will thrive in most of the various situations in the Southwest, as a reference to the grouping according to climatic adaptations will show. Probably the most generally useful of the list for posts is the Sugar Gum (*Eucalyptus corynocalyx*). It thrives in most situations in the Southwest; makes a fairly rapid growth; has a straight, even stem, especially when grown in blocks; and furnishes material for very durable posts. The Forest Red Gum (*E. tereticornis*) gives promise of proving nearly as useful for the above purposes.

Useful for piles: *Eucalyptus citriodora*, *E. globulus*, *E. hemiphloia*, *E. marginata*, *E. resinifera*, and *E. rostrata*.

Useful for street paving: *Eucalyptus citriodora*, *E. corymbosa*, *E. longifolia*, *E. pilularis*, *E. resinifera*, and *E. rostrata*.

Useful for telegraph poles: *Eucalyptus citriodora*, *E. pilularis*, *E. rostrata*, and *E. tereticornis*.

Useful for shipbuilding: *Eucalyptus diversicolor*, *E. globulus*, *E. pilularis*, *E. rostrata*, *E. siderophloia*, *E. sideroxylon*, and *E. tereticornis*.

Useful for vehicle making: *Eucalyptus botryoides*, *E. citriodora*, *E. cornuta*, *E. corynocalyx*, *E. diversicolor*, *E. globulus*, *E. goniocalyx*, *E. hemiphloia*, *E. melliodora*, *E. polyanthema*, and *E. punctata*.

Useful for agricultural implements: *Eucalyptus citriodora*, *E. cor-*

nuta, *E. corynocalyx*, *E. diversicolor*, *E. globulus*, *E. hemiphloia*, *E. pilularis*, *E. rostrata*, and *E. tereticornis*.

Useful for furniture and cabinet making: *Eucalyptus citriodora*, *E. microtheca*, and *E. resinifera*.

Useful as a source of oil: *Eucalyptus amygdalina*, *E. eugenioides*, *E. globulus*, and *E. rudis*.

Useful as a source of kino: *Eucalyptus calophylla*, *E. corymbosa*, *E. rostrata*, *E. siderophloia*, and *E. sideroxylon*.

Useful as a source of honey: *Eucalyptus calophylla*, *E. citriodora*, *E. corynocalyx*, *E. hemiphloia*, *E. leucoxylon*, *E. longifolia*, *E. melliodora*, *E. pilularis*, *E. polyanthema*, *E. rostrata*, *E. rudis*, *E. sideroxylon*, and *E. tereticornis*.

PART IV.

IDENTIFICATION OF EUCALYPTS.

Most of the seedling Eucalypts planted in the Southwest were not labeled when set out, and the identity of the adult trees thus usually became a matter of uncertainty. The identification of a particular Eucalypt tree is often of great importance. It may be one that is thriving in the situation in which it is growing, but unless its name be ascertained its value as a timber tree can not be known without putting the wood to an actual test, and thus destroying the tree. Or it may be known to be a desirable tree for some particular purpose or purposes, but the tree may not produce fertile seed from which it may be propagated. Moreover, a tree might thrive and produce fertile seed, but without a knowledge of its name the tree could not be written about or spoken of conveniently. Without knowing its name, seed or plants of the same species could not well be ordered by one desirous of obtaining them. It is also a matter of considerable interest to the possessor of Eucalypt trees to be able to establish for himself the identity of each of them. For the foregoing and for other reasons the identification of individual Eucalypts is a matter of great importance. The more thoroughly the tree is known from all standpoints, the more rapidly will information concerning it be disseminated. And the better the merits of the tree are understood, the more widely and extensively will it be planted.

It being necessary that students of Eucalypts pursue a more systematic method of identifying specimens of the genus than would be possible through the use of the preceding pages, the following treatment of the genus from a botanical standpoint is appended. The descriptions of the family to which the genus Eucalyptus belongs, and also the description of the genus and species are modified from those given in the works of Baron von Mueller, Mr. George Bentham, and Mr. J. H. Maiden. Descriptions are included of only those species the individuals of which reach at least 50 feet in height and 1 foot in diameter. Very brief descriptions are given of those species which have been discussed more fully in the preceding pages. Somewhat fuller descriptions are given of those not so fully treated previously. Brief statements are also made as to the utility of these latter species. What are supposed to be specimens of many of the 28 species described in the botanical part only of this publication are now growing in the South-

west. Not until they fruit, however, will their identity be fully established. As stated before, it was thought best to discuss in detail in the preceding pages only those species that have been positively identified in the Southwest by means of their flowers and seed-cases, leaving the other arboreal species to be mentioned only in this botanical section.

SYSTEMATIC POSITION OF THE EUCALYPTI.

The *Eucalypti* belong to the family Myrtaceæ, which may be characterized as follows:

Trees or shrubs; leaves opposite or alternate, usually dotted; flowers regular or nearly so. Calyx-tube grown to the ovary at the base or up to the insertion of the stamens. Petals usually as many as calyx-lobes, very much imbricated in the bud, the external one sometimes larger than the others, but usually all nearly equal when expanded, sometimes all concrete and falling off in a single operculum, or rarely entirely wanting. Stamens indefinite, usually numerous, inserted in one or several rows on a disk; filaments free or rarely united into a ring or tube at the base, or into as many bundles as there are calyx-lobes; anthers 2-celled, versatile, or attached by the base, the cells open in longitudinal slits, or rarely in terminal pores. Ovary inclosed in the calyx-tube, sometimes 1-celled, with a placenta attached to the base or adnate to one side; more frequently 2 or more celled, with the placentas in the inner angle of each cell; very rarely 1-celled with 2 parietal placentas. Style simple, with a small capitate or lobed stigma. Ovules 2 or more to each placenta, in 2 or more rows, or very rarely solitary. Fruit adnate to the calyx-tube, capsular and opening at the summit in as many valves as cells, or indihescent, dry and 1-seeded, or succulent and indihescent. Perfect seeds usually very few or solitary in each cell, even when the ovules are numerous, or rarely numerous and perfect.

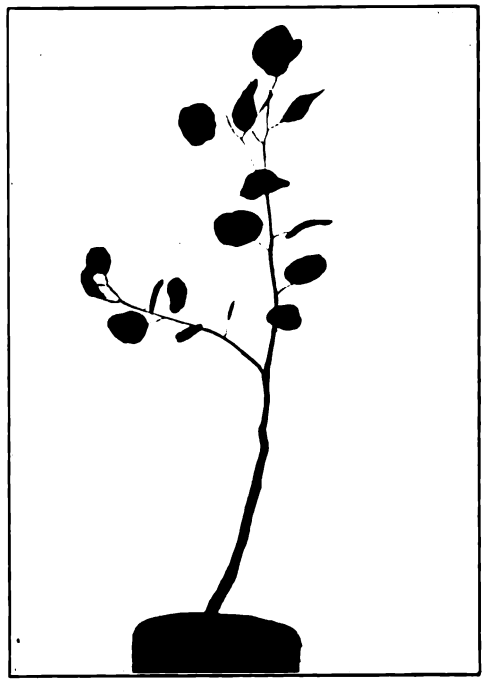
The family is divided into four tribes, the Eucalypti falling into the tribe Leptospermæ (meaning "small seeds"), the chief characteristic of which is its 2 to 5 celled ovary opening at the summit by as many valves as there are cells. Of the genera belonging to this tribe, the genus Eucalyptus is by far the largest, including about 150 known species. This genus was first described by the French botanist L'Héritier in 1788. The first species discovered and described by him was *Eucalyptus obliqua.*

BOTANICAL DESCRIPTION OF GENUS.

Eucalyptus L'Her.

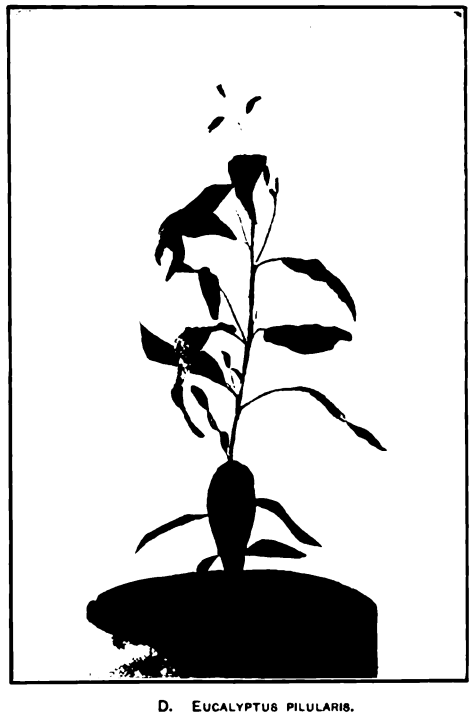
Evergreen trees, scattered as well as gregarious, sometimes of enormous height, some dwarfed shrubs, present in all parts of Australia in intratropic lowlands, in arid desert sands, and in alpine situations, occurring more scantily in New Guinea, in Timor, and very rarely in the Moluccas. Mostly of rapid growth, flowering occasionally at a very early age; bark either completely persistent or its outer layers deciduous; matured wood always hard; main branches usually distant; foliage often not dense; branches frequently pendent, usually quite glabrous, sometimes those of young plants rough, hairy. Leaves of old plants usually glabrous and thick in texture, usually scattered and with conspicuous stalks, in a few species opposite, and then generally without stalks, sometimes united; leaves of young plants frequently different in texture, position, and shape from those of older plants; the latter generally approaching in form to lanceolar-sickle-shaped, the upper and lower surfaces

A. EUCALYPTUS MELLIODORA.



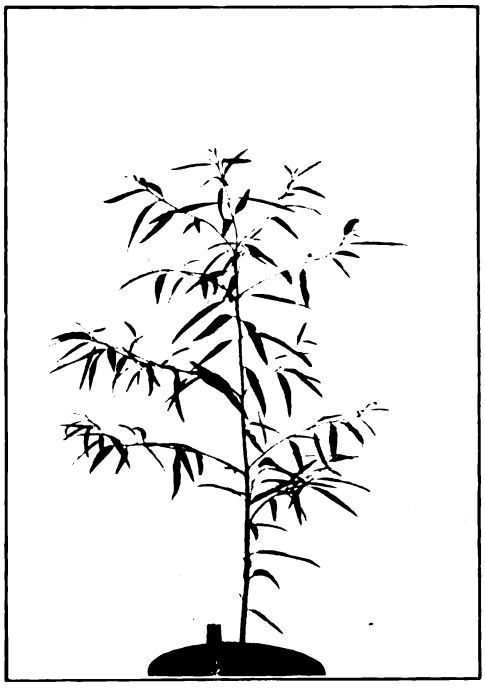
B. EUCALYPTUS POLYANTHEMA.

C. EUCALYPTUS OBLIQUA.



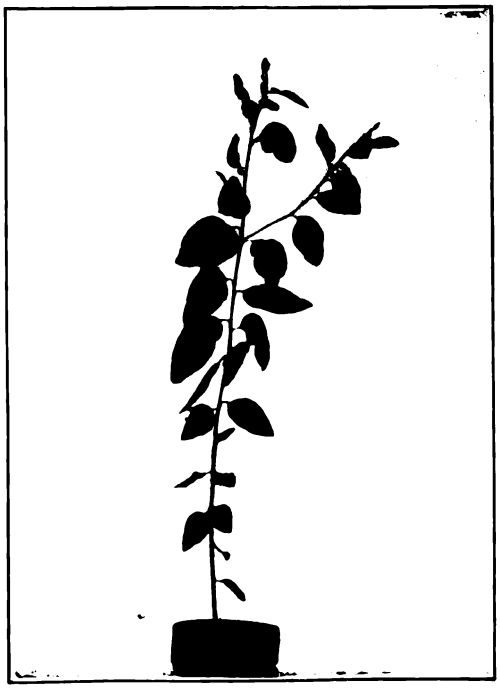
D. EUCALYPTUS PILULARIS.

EUCALYPT SEEDLINGS.

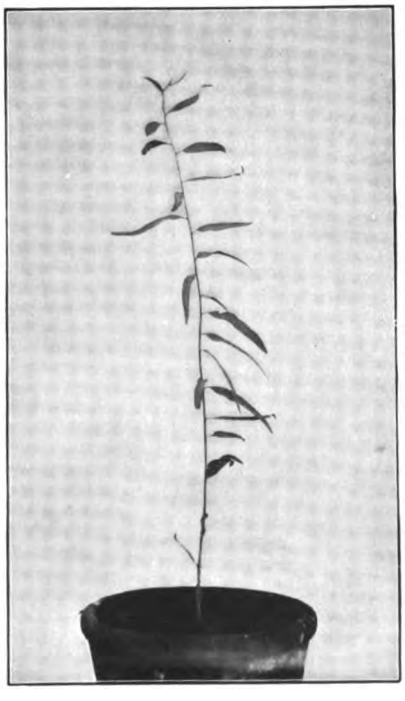


A. EUCALYPTUS RESINIFERA.

B. EUCALYPTUS PUNCTATA.



C. EUCALYPTUS TERETICORNIS.



D. EUCALYPTUS ROSTRATA.

EUCALYPT SEEDLINGS.

often of the same color and one edge of the leaf being turned upward and the other toward the ground; much less frequently considerably darker above and spreading horizontally; oil dots pellucid or concealed; peculiarly and strongly odorous; primary veins often numerous and much spreading. Inflorescence either axillary or terminal, or more rarely both modes united; flowers in single or paniculated umbels, rarely in twos, or solitary; umbel stalks and flower stalklets commonly present, the former sometimes much dilated; umbels while very young inclosed in a pair of fugacious and sometimes diminutive bracts; calyx very variable in size; lid often provided with a minute early deciduous accessory outer layer.

Calyx of firm texture and separated into a lower persistent portion and a deciduous lid. Petals none, unless represented in some few species by an inner membrane. Stamens very numerous, inserted close to the edge of the calyx tube in several rows, all fertile or some of the outer by absence of anthers sterile, always finally deciduous; filaments thread-like, pointed, inflexed while in bud, or the outer or very seldom all filaments straight before expansion; anthers dorsified, their two cells parallel or divergent, each opening by a marginal or anterior slit or less commonly by a pore. Style long; stigma convex or almost flat, undivided, seldom much dilated beyond the summit of the style. Ovary 2- to 6-celled, its lower portion grown to the calyx, its upper portion more or less free. Ovules in each cell numerous, the majority remaining unfertilized. Cotyledons broad, much compressed, somewhat folded, undivided or 2-lobed, curved around the cylindrical straight, erect radicle. Fruits for a long while persistent, form very small in some species to remarkably large in others, oftener smooth than streaked or ridged, valves always glabrous, very rarely permanently connected by the persistent base of the style. Seeds long retained in the persistent fruit, but soon shed on detachment of the latter; fertile seeds usually outside, dark brown; sterile seeds mostly pale brown and smaller than the others.

DETERMINATION OF SPECIES.

To identify the species of so large a genus is a difficult task. The system of identification adopted below is based on the structure of the anthers, the position of the valves, the shape of the lid, the form of inflorescence, and the similarity or dissimilarity of the two leaf surfaces. The first thing to ascertain about a Eucalypt that one wishes to identify by the use of the key below is the structure of the anthers. This can usually be done with a good lens by examining anthers from buds just ready to open. In using the key, the second thing to ascertain is whether the valves of a mature seed case are inclosed within it or project partly or wholly from the mouth. It is hoped that the accompanying plates will aid in the work of identification. (Pls. XC and XCI.)

It must be understood that all specimens will not plainly fall into any particular subdivision of the genus, and can not therefore be readily identified, especially by a beginner. But with a little patience and wider experience it will be found that most trees can be identified by the use of the keys and reference to the descriptions and illustrations. When a specimen has been traced to the species to which it is thought to belong, it should be ascertained if the species has been treated in detail earlier in the publication. If so, reference to the description and to the illustrations of the species in question will aid

in verifying or correcting the identification. The descriptions that follow apply to adult trees only.

ARTIFICIAL KEY TO SPECIES.

Anthers broader than long, usually kidney-shaped, and opening by slits that when joined are nearly horseshoe-shaped ..... *Renantheræ*
- Valves completely inclosed:
  - Lid hemispheric:
    - Veins running longitudinally 1
    - Veins spreading from midrib:
      - Leaves of adult trees mostly opposite 3
      - Leaves of adult trees alternate:
        - Leaves oblique, broad 9
        - Leaves not oblique, narrow:
          - Leaves equally green above and below 2, 12
          - Leaves paler beneath 8
  - Lid not hemispheric:
    - Leaves equally green above and below 4, 5
    - Leaves paler beneath 6, 7
- Valves partly exserted:
  - Lid hemispheric:
    - Leaves equally green above and below:
      - Fruits semiovate 13
      - Fruits urn-shaped 16
    - Leaves paler beneath 14
  - Lid not hemispheric 15
- Valves completely exserted:
  - Lid hemispheric 10
  - Lid sharp-pointed 11

Anthers not or hardly broader than long, opening by two pores ..... *Porantheræ*
- Valves deeply inclosed:
  - Leaves equally green above and below 23
  - Leaves paler beneath 17
- Valves completely but not deeply inclosed:
  - Leaves of adult trees broad 21, 22
  - Leaves of adult trees elongated:
    - Umbels paniculated 23
    - Umbels solitary:
      - Flowers in threes 18
      - Flowers not in threes 19, 20
    - Umbels solitary or racemose 24
- Valves barely inclosed 25

Anthers as long as or longer than broad, opening by nearly parallel slits ..... *Parallelantheræ.*
- Valves completely inclosed:
  - Umbels solitary:
    - Leaves equally green above and below:
      - Leaves opposite 42
      - Leaves alternate:
        - Flowers mostly in threes 42, 62
        - Flowers 3 to 8:
          - Calyx angled 62
          - Calyx not distinctly angled 32, 51

Anthers as long as or longer than broad, etc.--Continued.
Valves completely inclosed—Continued.
Umbels solitary—Continued.
Leaves paler beneath:
Stalk broadly compressed 60, 61, 63
Stalk not broadly compressed:
Lid broader than calyx 38
Lid not broader than calyx 33
Umbels paniculated:
Leaves equally green above and below:
Leaves lemon-scented 40
Leaves not lemon-scented 37, 39, 41
Leaves paler beneath:
Fruits less than one-half inch in length:
Stalks broadly compressed 55
Stalks not broadly compressed 27
Fruits over one-half inch in length:
Stalklets short or none 35
Stalklets long 34, 36
Valves partly exserted:
Umbels solitary:
Leaves equally green above and below:
Stalklets broadly compressed, or angular:
Lid acute 51, 55
Lid not acute 56, 57
Stalks not broadly compressed:
Fruits large, 1 inch in diameter 67
Fruits small:
Leaves broad 44
Leaves narrow 49, 53
Leaves paler beneath:
Lid hemispheric 57
Lid pointed 59
Umbels paniculated:
Stalk broadly compressed 59
Stalk not broadly compressed:
Stalklets thick and angular 30
Stalklets slender and round 26
Valves completely exserted:
Umbels solitary:
Leaves equally green above and below:
Lid short, below one-fourth inch in length:
Lid sharp-pointed 47
Lid blunt:
Leaves broad 44
Leaves slender:
Valves long and slender 31
Valves short:
Flowers in threes 46, 52
Flowers more than 3 ..... 45, 46
Lid long, above one-fourth inch in diameter:
Valves coherent 64
Valves not coherent 48, 54

Anthers as long as or longer than broad, etc.—Continued.
Valves completely exserted—Continued.
Umbels solitary—Continued.
Leaves paler beneath:
Lid broader than calyx 64
Lid not broader than calyx 57, 58
Umbels paniculated:
Leaves equally green above and below 29
Leaves paler beneath 28

BOTANICAL DESCRIPTION OF SPECIES.

RENANTHEREÆ.

1. **E. coriacea** A. Cunn. Leaves elongated, thick, shining, equally green above and below, veined longitudinally; umbels solitary, lid hemispheric; fruits truncate-ovate, border of orifice depressed, valves inclosed.

2. **E. amygdalina** Lab. Leaves thin, equally green above and below; veins not much spreading, oil-dots copious, transparent; umbels solitary, flowers small, lid almost hemispheric; fruits truncate-ovate, border depressed, valves inclosed.

3. **E. risdoni** Hook. Leaves, sometimes all, even on the flowering branches, opposite, ovate-cordate and more or less connate, or sometimes those of the flowering branches alternate, broadly lanceolate and falcate, rather thick, with oblique veins scarcely conspicuous, the intramarginal one at a distance from the edge. Peduncles axillary or lateral, terete or angular, bearing each an umbel of 4 to 8 flowers. Fruit subglobose-truncate, the rim rather broad, flat; valves inclosed. Bark smooth, coming off in regular patches, varying from whitish to dark brown.

Adapted to cool, moist regions.

4. **E. stellulata** Sieb. Leaves small, thick, equally green above and below, veined longitudinally; umbels solitary, flowers very small, numerous, lid semiovate-conical; fruits truncate-globular, border depressed, valves inclosed. Bark rough, scaly and fibrous.

Adapted to cool, moist regions.

5. **E. eugenioides** Sieb. Leaves equally dark green above and below, shining, very inequilateral at the base, much transparently dotted; umbels mostly solitary, lid semiovate; fruits truncate-globular, border depressed, valves barely inclosed.

6. **E. piperita** Sm. Leaves less shining beneath, with many transparent dots; umbels solitary, lid semiovate-conical; fruits truncate-ovate, border compressed, valves inclosed.

7. **E. pilularis** DC. Leaves rather less shining beneath; umbels mostly axillary, their stalks compressed, lid semiovate-conical; fruits truncate-ovate, border depressed, valves inclosed.

8. **E. acmenoides** Sch. Leaves paler beneath; umbels mostly axillary, their stalks slender, lid hemispheric, pointed; fruits truncate-ovate, border compressed, valves barely inclosed. Bark rough, persistent, and fibrous.

Adapted to tropical coast regions. Timber valuable.

9. **E. obliqua** L'Her. Leaves equally green above and below, shining, very inequilateral at the base; umbels solitary, calyces granular-rough, lid hemispheric; fruits truncate-ovate, border compressed, valves inclosed.

10. **E. capitellata** Sm. Leaves thick, elongated, rather less shining beneath, very inequilateral at the base; umbels axillary, stalklets none, lid hemispheric; fruits semiovate below, border broad, convex, emersed, valves much exserted. Bark stringy and persistent.

Adapted to cool, moist regions. Furnishes a valuable timber.

11. **E. macrorhyncha** F. v. M. Leaves elongated, equally green above and below; umbels solitary; calyx lid concavely attenuated, sharply pointed; fruits below hemispheric, border convex, emersed, valves much exserted.

12. **E. haemastoma** DC. Leaves equally green above and below, very shining; umbels solitary, stalks somewhat compressed; outer stamens sterile; fruits semiovate, border depressed, valves very short, inclosed.

13. **E. sieberiana** F. v. M. Leaves elongated, thick, pale, equally green above and below, shining; veins thin, not much spreading; umbels solitary, their stalks compressed, lid hemispheric; outer stamens sterile; fruits truncate-ovate, border depressed, valves very short, barely inclosed. Bark rough and persistent.

Grows to an elevation of 4,000 feet in Australia. Timber valuable.

14. **E. microcorys** F. v. M. Leaves thin, much paler beneath, much transparently dotted, veins spreading; umbels partly paniculated, stalklets elongated, lid very small, hemispheric; outer stamens sterile; fruits hemiellipsoid, border compressed, valves minute, barely inclosed. Bark rough and persistent.

A large tree, furnishing a hard, durable timber. Adapted to moist semitropic regions.

15. **E. marginata** Sm. Leaves paler beneath, veins spreading; umbels solitary, lid conical; outer stamens straight in bud; fruits globular-ovate, truncate, border compressed, valves very short, barely inclosed.

16. **E. baileyana** F. v. M. Leaves thin, equally green above and below, with many transparent dots; umbels mostly solitary; lid hemispheric; fruits globular-urn shaped, border compressed, valves barely inclosed. Bark fibrous and persistent.

Does quite well on very poor sandy ridges. Wood tough and durable.

PORANTHEREÆ.

17. **E. paniculata** Sm. Leaves rather thin, paler beneath, umbels mostly paniculated; lid thin, conical-semiovate; outer stamens sterile; anthers truncated, opening at the summit; stigma much dilated; fruit semiovate, border of orifice compressed, valves inclosed.

18. **E. leucoxylon** F. v. M. Leaves equally dull green above and below; umbels solitary, mostly three-flowered, stalklets elongated; lid semiovate pointed; outer stamens sterile, anthers truncated, opening at the summit; stigma much dilated; fruits semiovate, border compressed, valves inclosed.

19. **E. sideroxylon** A. Cunn. Leaves equally green above and below, narrow, often glaucous; umbels solitary, several-flowered, stalklets elongated; lid semiovate pointed; anthers truncate, opening at the summit; fruits semiovate, valves inclosed.

20. **E. melliodora** A. Cunn. Leaves equally dull green above and below; umbels solitary; flowers small; lid conic-hemispherical; outer stamens sterile; anthers truncated, opening at the summit; stigma much dilated; fruits truncate-ovate, border compressed, valves inclosed.

21. **E. polyanthema** Sch. Leaves broad, equally dull green above and below; umbels paniculated; lid almost hemispheric; outer stamens sterile; anthers truncated, opening at the summit; fruit truncate-ovate, border compressed, valves inclosed.

22. **E. populifolia** Hook. Leaves broad, equally green above and below, shining, long-stalked, with many transparent dots; stalklets very short; umbels paniculated; lids hemispheric; fruit small, semiovate, border rather depressed, valves close to the summit, barely inclosed.

23. **E. hemiphloia** F. v. M. Leaves thick, elongated, equally green above and below; umbels paniculated; calyces somewhat angular; lid semiovate-conical; fruit hemiellipsoid, border compressed, valves inclosed.

24. **E. boristoana** F. v. M. Leaves narrow, equally dull green above and below, copiously dotted with translucent oil glandules, lateral veins distant and much divergent, marginal vein distant from the edge; umbels solitary or racemosely arranged, few flowered; stalks elongated, generally somewhat compressed; calyx tube slight angular; lid semiovate-hemispheric; fruits small, nearly semiovate, valves inclosed. Bark rough on the lower part of the trunk, smooth on the upper.

Adapted to low lands in fairly humid regions. Timber valuable.

25. **E. largiflorens** F. v. M. Leaves thin, equally dull green above and below; umbels paniculated; lid double, the inner hemispheric, less wide than the calyx tube; outer stamens sometimes sterile; fruit small; lid hemispheric; fruit truncate-ovate, border rather compressed, valves inclosed.

PARALLELANTHEREÆ.

26. **E. crebra** F. v. M. Leaves narrow, thin, equally dull green above and below, veins spreading; umbels mostly paniculated; flowers small; lids semiovate-conical; stigma dilated; fruits small, semiovate, border compressed, valves short, somewhat exserted. Bark rough and persistent.

27. **E. howittiana** F. v. M. Leaves much paler beneath; umbels paniculated; stalklets none; flowers very small; lid conical, acute, pale; fruits minute, truncate-globular, border compressed, valves inclosed. Bark rough, somewhat fibrous, and persistent.

Useful as a shade tree. Wood valuable. Particularly adapted to tropical regions.

28. **E. raveretiana** F. v. M. Leaves thin, somewhat paler beneath; oil-dots pellucid; umbels paniculated; lid conical, acute; fruits minute, semiglobular beneath, border compressed, valves much exserted. Bark usually rendered smooth by the peeling off of the outer layer. Tree attains a gigantic size.

Promising for swampy situations in tropics. Wood very hard and durable.

29. **E. microtheca** F. v. M. Leaves equally dull and pale green; umbels paniculated; lid semiovate; fruits small, semiglobular beneath, border compressed, valves much exserted.

30. **E. siderophloia** Benth. Leaves elongated, equally green above and below; umbels partly paniculated; lid conical, very acute; outer stamens straight in bud; fruits semiovate, border compressed, valves somewhat exserted.

31. **E. salmonophloia** F. v. M. Leaves equally green above and below, shining; oil-dots numerous; umbels solitary; stalks slender, stalklets short; lid semiovate-conical; outer stamens straight in bud; fruit small, semiovate, border compressed, valves long-pointed, much exserted. Bark smooth.

Promising for dry interior valleys.

32. **E. patens** Benth. Leaves thin, elongated, almost equally dull green above and below; umbels mostly axillary; lid nearly hemispheric; fruits truncate-ovate, somewhat streaked, border compressed, valves inclosed. Bark rough and persistent.

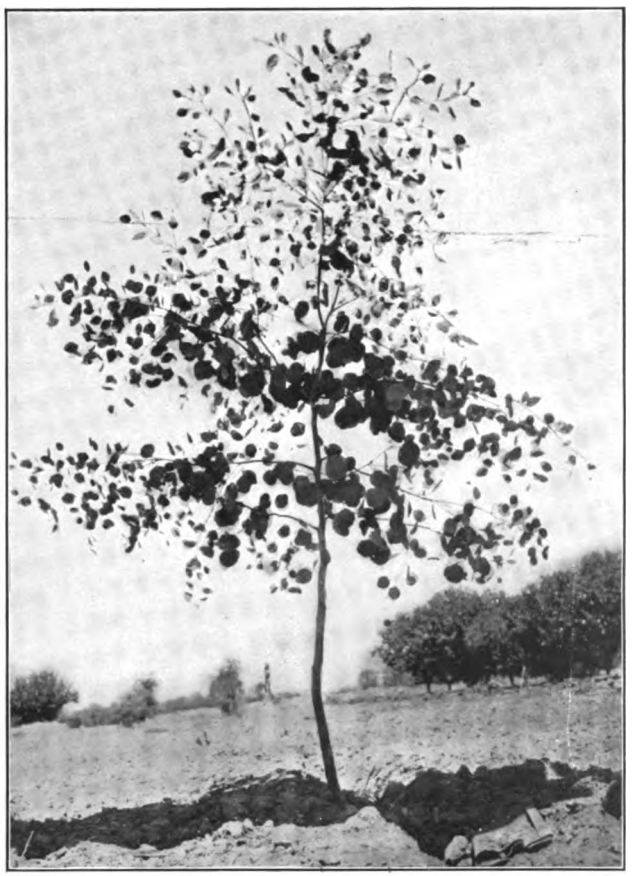
Timber not particularly valuable.

33. **E. diversicolor** F. v. M. Leaves elongated, much paler beneath; umbels solitary; lid nearly hemispheric; fruits truncate-ovate, attenuated at the base, border compressed, valves inclosed.

34. **E. calophylla** R. Br. Leaves broad, acute, much paler beneath, veins feather-spreading; umbels paniculated; stalklets elongated; lid patellar, less wide than the calyx tube, tearing off along an irregular suture; fruits large, smooth, ovate urn-shaped; border compressed, valves inclosed; fertile seeds, terminating in a large membrane.

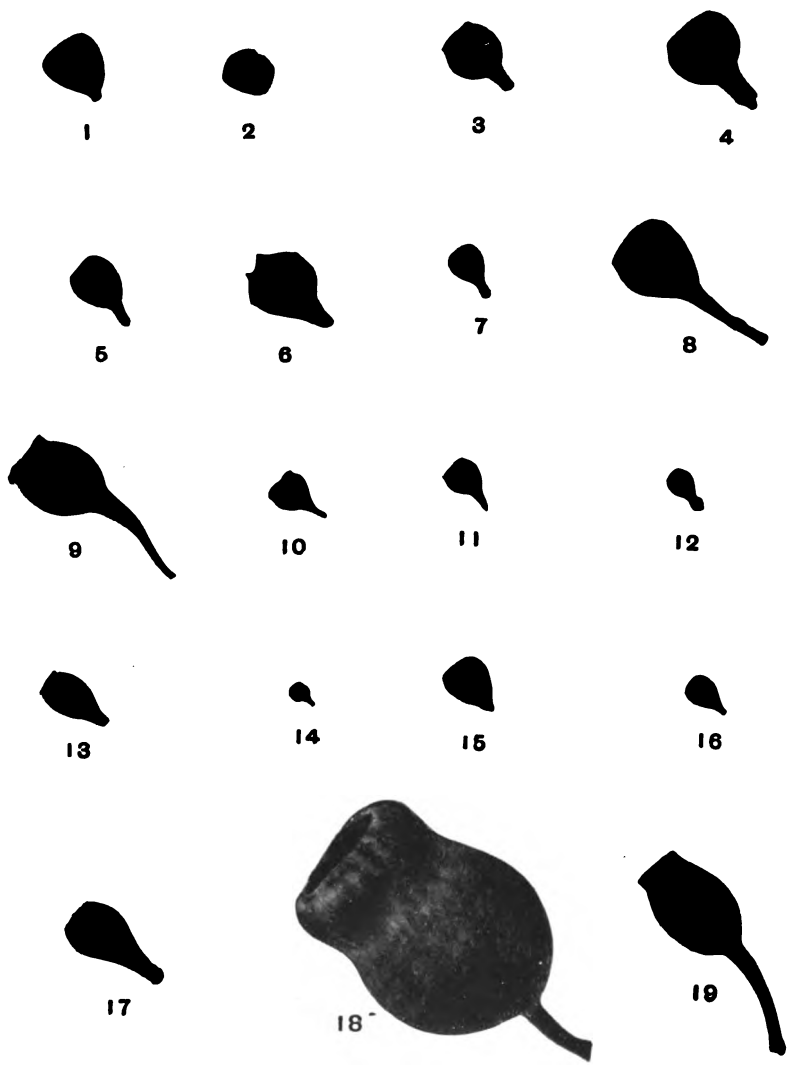
35. **E. abergiana** F. v. M. Leaves thick, broadish, acute, much paler beneath;

A. EUCALYPTUS RUDIS. 1 YEAR OLD.



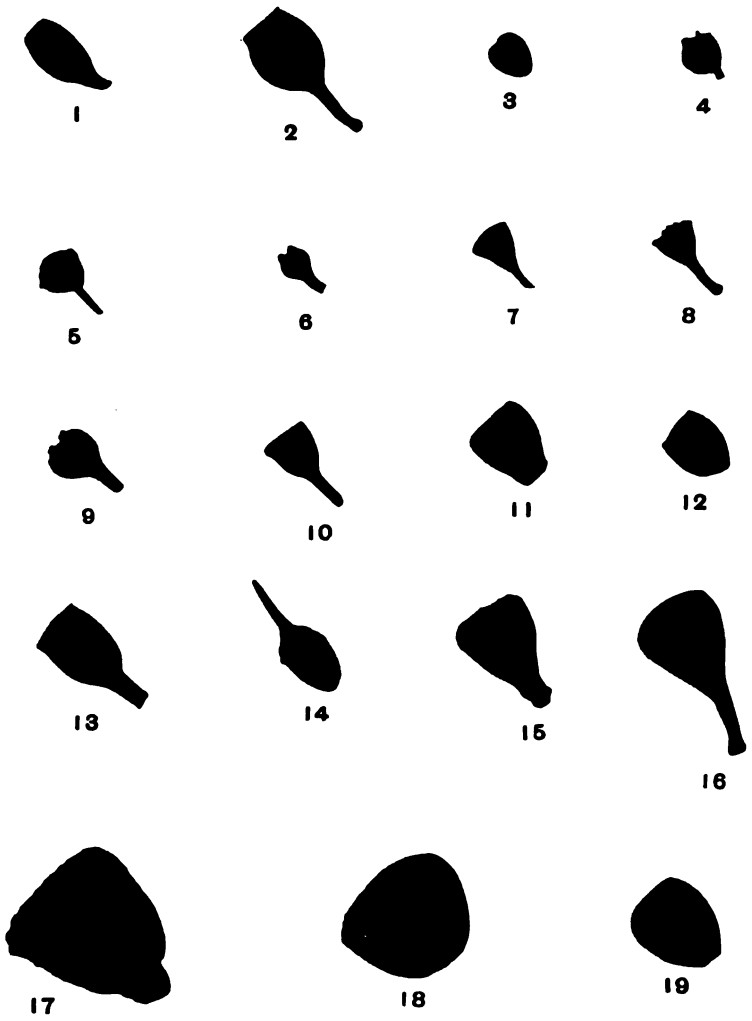
B. EUCALYPTUS POLYANTHEMA. 2 YEARS OLD.

YOUNG EUCALYPTS AT EXPERIMENT STATION FARM, PHOENIX, ARIZ.



EUCALYPTUS FRUITS. NATURAL SIZE.

1, Eucalyptus amygdalina; 2, E. eugenioides; 3, E. piperita; 4, E. pilularis; 5, E. obliqua; 6, E. macrorhyncha; 7, E. paniculata; 8, E. leucoxylon; 9, E. sideroxylon; 10, E. melliodora; 11, E. polyanthema; 12, E. populifolia; 13, E. hemiphloia; 14, E. microtheca; 15, E. siderophloia; 16, E. crebra; 17, E. diversicolor; 18, E. calophylla; 19, E. corymbosa.



EUCALYPTUS FRUITS. NATURAL SIZE.

1, Eucalyptus corynocalyx; 2, E. citriodora; 3, E. stuartiana; 4, E. viminalis; 5, E. rostrata; 6, E. tereticornis; 7, E. gunnii; 8, E. rudis; 9, E. resinifera; 10, E. punctata; 11, E. botryoides; 12, E. goniocalyx; 13, E. robusta; 14, E. cornuta; 15, E. occidentalis; 16, E. longifolia; 17, E. globulus; 18, E. gomphocephala; 19, E. coriacea.

veins feathery-spreading; umbels paniculated; stalklets almost none; lid hemispheric; tearing off along an irregular suture; fruits large, smooth, ovate-urnshape, border compressed, valves inclosed; fertile seeds terminating in a large membrane. Bark rough and persistent.

A large tree, promising for tropical countries.

36. **E. corymbosa** Sm. Leaves thick, broad to narrow lanceolate, much paler beneath; veins feathery-spreading; umbels paniculated; stalklets elongated; lid short, tearing off along an irregular suture; fruits rather large, smooth, ovate-shaped, border compressed, valves inclosed; fertile seeds terminating in a very short membrane.

37. **E. tessellaris** F. v. M. Leaves narrow, elongated, equally green above and below; umbels mostly paniculated; stalklets very short; lid patellar, shining; fruits truncate-ovate, slightly urceolar; border compressed, valves inclosed; fertile seeds almost flat, membraneous-margined. Bark rough and persistent on the lower part of the trunk; remainder of trunk smooth.

Promising for hot, dry regions free from frost.

38. **E. corynocalyx** F. v. M. Leaves shining, somewhat paler beneath; umbels mostly solitary; lid almost hemispheric, slightly overreaching the orifice of the calyx; fruits urnshaped-ellipsoid, streaked; border compressed, valves inclosed.

39. **E. maculata** Hook. Leaves elongated, equally green above and below; veins feathery-spreading; umbels paniculated; stalklets short; lid double, hemispheric, the inner thin, shining; fruit truncate-ovate, somewhat urnshaped, border compressed, valves inclosed. Bark smooth, falling off in patches and thus giving the trunk a spotted appearance.

Thrives on stony ridges; susceptible to frost; wood useful for paving.

40. **E. citriodora** Hook. Leaves long and narrow, equally shiny green above and below, veins spreading; umbels paniculated; stalklets short; lid hemispheric; fruit truncate-ovate, somewhat urn-shaped, border compressed, valves inclosed.

41. **E. eximia** Sch. Leaves thick, elongated, equally green above and below; umbels paniculated; stalklets none; lid thin, hemispheric, shining, imperfectly double; fruit rather large, truncate ovate, somewhat urnshaped, border compressed, valves inclosed; fertile seeds large. Bark rough and persistent.

A medium-sized tree furnishing good fuel.

42. **E. cordata** Lab. Leaves opposite, sessile, mostly cordate, crenulated, equally dull green above and below; oil-glands pellucid; umbels solitary; stalklets none; fruits semiovate, border compressed, at the edge annular, valves barely inclosed. Bark thin, solid, slightly wrinkled.

43. **E. urnigera** Hook. Leaves scattered, long-stalked, almost lanceolar, crenulated, equally dark green; oil glands pellucid; umbels solitary; stalks elongated, stalklets rather short; fruits ellipsoid-urnshaped, border compressed, at the edge annular, valves deeply inclosed. Bark smooth, pale brown.

A small tree that endures low temperatures.

44. **E. platyphylla** F. v. M. Leaves often large, cordate or ovate roundish, long-stalked, equally dull green above and below; umbels solitary; stalks short, stalklets almost none; lid blunt; fruits small, semiovate, border depressed, valves exserted. Bark smooth and deciduous.

45. **E. stuartiana** F. v. M. Leaves scattered, stalked, equally dark green, shining; umbels solitary; few-flowered stalklets almost none; lid nearly hemispheric; fruits small, semiovate-top shaped, border narrow, rather convex, valves very small, exserted.

46. **E. viminalis** Hook. Leaves scattered, stalked, falcate-lanceolar, equally green

above and below; umbels solitary, mostly three-flowered; stalklets almost none or very short; lid semiovate, mostly short-pointed; fruit semiovate, border somewhat convex, valves exserted.

47. **E. rostrata** Schl. Leaves scattered, stalked, falcate-lanceolar, equally green above and below; umbels solitary, with several flowers; stalks rather elongated, stalklets conspicuous; lid from an hemispheric base sharp-pointed; fruit below semiglobular, border convex, valves exserted.

48. **E. tereticornis** Sm. Leaves scattered, stalked, falcate-lanceolar, equally green above and below; umbels solitary, with several flowers; stalks rather elongated, stalklets conspicuous; lid mostly elongate-conical; outer stamens straight in bud; fruits below semiglobular, border convex, valves exserted.

49. **E. macarthuri** D. and M. Leaves narrow, lanceolate, thickish, equally green above and below; umbels axillary and solitary, with several flowers; stalks short, stalklets very short or none; lid somewhat conical; fruits very small, nearly hemispherical, slightly dilated at the rim, valves usually three, scarcely exserted. Bark rough and woolly.

Prefers swampy or river-bottom land. Timber not very valuable.

50. **E. quadrangulata** D. and M. Leaves lanceolate, slightly falcate, usually 4 to 6 inches long, scarcely paler on the under surface; umbels axillary, solitary; stalks broadish and strongly compressed, stalklets none; lid somewhat conical; fruits small, shining, bell-shaped, valves usually three, slightly exserted. Bark rough and persistent, fuzzy.

51. **E. acaciaeformis** D. and M. Leaves lanceolate, of medium size, margins often crenulate, equally green; umbels solitary, with several flowers; stalks very angular or flattened, stalklets short and angular; lid slightly pointed; fruits small, elongate-hemispherical, valves scarcely exserted. Bark somewhat fibrous.

52. **E. rubida** D. and M. Leaves narrow-lanceolate, thickish, intramarginal vein scarcely removed from the edge, equally dull-green above and below; umbels solitary, three-flowered; stalks of medium length, stalklets very short or none; lid nearly hemispherical; fruits top-shaped or nearly hemispherical, rim convex, valves exserted. Bark smooth, falling off in strips.

Grows on mountain sides. Timber not valuable.

53. **E. gunnii** Hook. Leaves scattered, stalked, thick, broadish-lanceolar, equally dark green above and below, shining; umbels solitary, with several flowers; stalklets very short; lid shining, hemispheric, short-pointed; fruits topshaped-semiovate, border depressed, valves small, slightly exserted.

54. **E. rudis** End. Leaves thin, falcate-lanceolar, equally dull-green above and below; oil-dots pellucid; umbels solitary; stalklets short; lid broad-conical, transverse edge of the calyx prominent in bud; fruits semiglobular top-shaped, border rather convex, valves exserted.

55. **E. redunca** Sch. Leaves equally green above and below; umbels solitary; stalks broadly compressed, lid conical, acute; fruit hemiellipsoid, border compressed, valves inclosed. Bark smooth.

In good soil grows to a large size and furnishes valuable timber.

56. **E. salubris** F. v. M. Leaves thin, equally dark-green above and below; oil-dots numerous, pellucid; umbels solitary, stalks compressed; lid hemiellipsoid; fruits semiovate, border depressed, very narrow, valves small, exserted. Bark smooth and shining.

Promising for desert regions; endures high temperatures and considerable frost. Timber valuable. Leaves rich in oil.

57. **E. saligna** Sm. Leaves much paler beneath, veins feathery-spreading;

umbels solitary; stalk compressed, stalklets very short; lid hemispheric, short-pointed; fruit semiovate, border depressed, very narrow, valves small, exserted.

58. **E. resinifera** Sm. Leaves much paler beneath, veins very spreading; umbels solitary; stalk compressed; lid conical, acute; fruit semiovate, border depressed, narrow, valves exserted, pointed.

59. **E. punctata** DC. Leaves paler beneath, veins very spreading, oil dots pellucid; umbels partly paniculated; stalks broadly compressed; lid semiovate-conical; fruit semiovate, border depressed, valves small, barely exserted.

60. **E. planchoniana** F. v. M. Leaves elongated, shining, slightly paler beneath; umbels solitary; stalks broadly compressed, stalklets short; lid broadish-conical, acute; outer stamens straight in bud; fruits rather large, semiovate, streaked, border compressed, valves inclosed. Bark rough.

Promising for hot, dry regions free from frost. Furnishes abundant shade. Timber valuable.

61. **E. botryoides** Sm. Leaves much paler beneath, veins feathery-spreading; umbels solitary; stalk broadly compressed, stalklets almost none; lids hemispheric; fruit hemiellipsoid, border compressed, valves inclosed.

62. **E. goniocalyx** F. v. M. Leaves equally green above and below; umbels solitary, stalk compressed, stalklet very short; lid pyramidal-hemispheric; fruit truncate-ovate, angular, border narrow, depressed, valves inclosed.

63. **E. robusta** Sm. Leaves thick, broadish, somewhat paler beneath; umbels solitary, stalk broadly compressed; lid semiglobular-conical, broader than the calyx tube; fruit truncate-ovate, border compressed, valves coherent, inclosed.

64. **E. cornuta** Lab. Leaves lanceolate, equally green above and below; umbels solitary; stalklets almost none, lid very long, upward cylindrical; filaments yellow, long, straight in bud; fruit bell-shaped, semiovate, border depressed, valves exserted, very long, awl-shaped, coherent.

65. **E. occidentalis** End. Leaves thick, equally green above and below; umbels solitary; stalks broadly compressed, stalklets short; lid cylindric-conical; stamens straight in bud; fruits bell-shaped, semiovate, border depressed; valves exserted, pointed.

66. **E. longifolia** Lind. Leaves elongated, equally green above and below; umbels solitary, flowers in threes; stalklets elongated; calyces pale; lid broad-conical, acute; fruit rather large, bell-shaped, semiovate, angular, border ascendant, valves inclosed.

67. **E. globulus** Lab. Leaves thick, elongated, equally green above and below; flowers mostly solitary, stalks and stalklets almost none; lid double, the inner crown-shaped; fruit large hemispheric, warty-rough, angular, border broad, depressed, valves exserted, convergent.

68. **E. gomphocephala** DC. Leaves thick, shining, slightly paler beneath; umbels solitary; stalk broadly compressed, stalklets none; lid broader than the tube of the calyx, almost hemispheric; fruit large, top-shaped, border broad, convex, valves exserted, convergent.

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INDEX.

Page

Blue Gum. (*See* Eucalyptus globulus and Eucalyptus leucoxylon.)
Eucalypts:
- As improvers of climate 16, 42
- Common names 49
- Dissemination 14
- Distance apart for fuel 37
- Early blooming 28
- Effect on air and soil 43
- Native home 13
- Rapid growth 18, 25
- Significance of specific names 50
- Spontaneous growth 44
- Uses of timber 35, 36
- Wood 26
- Yield of wood 38

Eucalyptus abergiana, characteristics 96
Eucalyptus acaciæformis, characteristics 98
Eucalyptus acmenoides, characteristics 94
Eucalyptus amygdalina:
- Characteristics 51, 94
- Great size 52
- Uses 52
- Yield of oil 39

Eucalyptus baileyana, characteristics 95
Eucalyptus bosistoana, characteristics 96
Eucalyptus botryoides:
- Characteristics 53, 99
- Uses 53

Eucalyptus calophylla:
- Characteristics 53, 96
- Uses 54

Eucalyptus capitellata, characteristics 94
Eucalyptus citriodora:
- As a source of honey 55, 88
- Characteristics 54, 97
- Odor of foliage 54
- Oil 39
- Uses 55

Eucalyptus cordata, characteristics 97
Eucalyptus coriacea:
- Characteristics 55, 94
- Resistance to frost 55
- Uses 55

Page.
Eucalyptus cornuta:
Characteristics 56, 99
Uses 56
Eucalyptus corynocalyx:
As a source of honey 42, 88
Characteristics 57, 97
Uses 58
Eucalyptus corymbosa:
As a source of kino 57
Characteristics 56, 97
Uses 57
Eucalyptus crebra:
Characteristics 59, 96
Uses 59
Eucalyptus diversicolor:
Characteristics 59, 96
Uses 60
Eucalyptus eugenioides:
Characteristics 60, 94
Uses 61
Eucalyptus eximia, characteristics 97
Eucalyptus globulus:
As a source of oil 40
Characteristics 61, 99
Extensive American use 51
General adaptability 62
Known as "fever tree" 16
Planchon on 14
Uses 38, 62
Yield of wood 37
Eucalyptus gomphocephala:
Characteristics 63, 99
Uses 63
Eucalyptus goniocalyx:
Characteristics 63, 99
Uses 64
Eucalyptus gunnii:
Characteristics 64, 98
Resistance to frost 64
Uses 64
Eucalyptus hæmastoma:
Characteristics 64, 95
Uses 65
Eucalyptus hemiphloia:
As a source of honey 42, 88
Characteristics 65, 95
Uses 65
Eucalyptus howittiana, characteristics 96
Eucalyptus largiflorens, characteristics 96
Eucalyptus leucoxylon:
Characteristics 66, 95
General adaptability 66
Uses 66

Page.
Eucalyptus longifolia:
Characteristics 66, 99
Uses 67
Eucalyptus macrorhyncha:
Characteristics 67, 95
Uses 67
Eucalyptus maculata, characteristics 97
Eucalyptus melliodora:
As a source of honey 68
Characteristics 68, 95
Uses 69
Eucalyptus microcorys, characteristics 95
Eucalyptus microtheca:
Characteristics 69, 96
Resistance to heat 69
Uses 69
Eucalyptus obliqua:
Characteristics 70, 94
Uses 70
Eucalyptus occidentalis:
Characteristics 70, 99
Uses 70
Eucalyptus oil, value and properties 40
Eucalyptus paniculata:
Characteristics 71, 95
Uses 71
Eucalyptus patens, characteristics 96
Eucalyptus pilularis:
Characteristics 71, 94
Uses 72
Eucalyptus piperita:
Characteristics 72, 94
Uses 72
Eucalyptus planchoniana, characteristics 99
Eucalyptus platyphylla, characteristics 97
Eucalyptus polyanthema:
Characteristics 73, 95
General adaptability 73
Uses 73
Eucalyptus populifolia:
Characteristics 73, 95
Uses 74
Eucalpytus punctata:
Characteristics 74, 99
Uses 74
Eucalyptus quadrangulata, characteristics 98
Eucalyptus raveretiana, characteristics 96
Eucalyptus redunca, characteristics 98
Eucalyptus resinifera:
Characteristics 74, 99
Uses 35, 75
Eucalyptus risdoni, characteristics 94

Page.
Eucalyptus robusta:
Characterictics 75, 99
Uses 76
Eucalyptus rostrata:
As a source of honey 42, 88
As a source of kino 77
As a source of stove wood 37
Characteristics 76, 98
Numerous uses 35, 77
Spontaneous growth 44, 77
Eucalyptus rudis:
Characteristics 78, 98
General adaptability 78
Spontaneous growth 44
Uses 78
Eucalyptus rubida, characteristics 98
Eucalyptus saligna:
Characteristics 79, 98
Uses 79
Eucalyptus salmonophloia, characteristics 96
Eucalyptus salubris, characteristics 98
Eucalyptus siderophloia:
Characteristics 79, 96
Uses 80
Eucalyptus sideroxylon:
As a source of stove wood 37
Characteristics 80, 95
Numerous uses 35, 80
Eucalyptus sieberiana, characteristics 95
Eucalyptus stellulata, characteristics 94
Eucalyptus stuartiana:
Characteristics 81, 97
Uses 81
Eucalyptus tereticornis:
Characteristics 81, 98
Uses 82
Eucalyptus tessellaris, characteristics 97
Eucalyptus urnigera, characteristics 97
Eucalyptus viminalis:
Characteristics 82, 97
Rate of growth 37, 82
Uses 83
Iron bark. (*See* Eucalyptus crebra, Eucalyptus paniculata, Eucalyptus siderophloia, and Eucalyptus sideroxylon.)
Manna Gum. (*See* Eucalyptus viminalis.)
Red Gum. (*See* Eucalyptus rostrata and Eucalyptus tereticornis.)
Sugar Gum. (*See* Eucalyptus corynocalyx.)
Stringy-bark. (*See* Eucalyptus eugenioides, Eucalyptus macrorhyncha, and Eucalyptus piperita.)

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